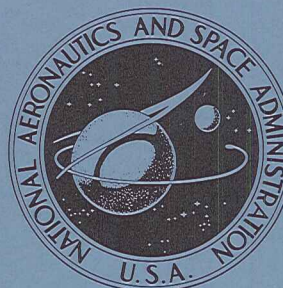


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A COMPUTER PROGRAM TO DETERMINE
RADIATING, NONADIABATIC,
INVISCID FLOW OVER A BLUNT BODY
BY THE METHOD OF INTEGRAL RELATIONS

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1. Report No. NASA TM X-2328	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle A COMPUTER PROGRAM TO DETERMINE RADIATING, NONADIABATIC, INVISCID FLOW OVER A BLUNT BODY BY THE METHOD OF INTEGRAL RELATIONS		5. Report Date October 1971	
		6. Performing Organization Code	
7. Author(s) Frances W. Taylor		8. Performing Organization Report No. L-7807	
		10. Work Unit No. 136-13-05-04	
9. Performing Organization Name and Address NASA Langley Research Center Hampton, Va. 23365		11. Contract or Grant No.	
		13. Type of Report and Period Covered Technical Memorandum	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract <p>A computer program (Langley program D1250) has been developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocities, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. This report describes the digital computer program including the methods used in the digital approximation, flow charts, D1250 program code, instructions for the user, and a test case with input and output listings.</p>			
17. Key Words (Suggested by Author(s)) Equilibrium air Blunt-body flow fields Integral-relations solutions Radiative heat transfer		18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 164	22. Price* \$3.00

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SUMMARY

A computer program (Langley program D1250) has been developed in support of the study of the radiating, nonadiabatic, inviscid flow properties (pressure, temperature, density, velocity, and enthalpy) around a blunt body in equilibrium air by use of a modified method of integral relations. This report describes the digital computer program including the methods used in the digital approximation, flow charts, D1250 program code, instructions for the user, and a test case with input and output listings.

INTRODUCTION

A modified approach to the first-order approximation in the method of integral relations for the numerical calculation of the inviscid, adiabatic, subsonic flow field about a blunt-nose body traveling at hypersonic speeds as described in references 1 and 2 has been extended to include the radiating nonadiabatic case (ref. 3). Langley computer program D1250 was developed to make the calculations for the radiating nonadiabatic flow of air in chemical equilibrium. Results obtained in reference 3 agree with results from inverse and time-dependent techniques. The agreement indicates that this relatively simple method of solution provides an accurate description of the blunt-body flow field in the subsonic region.

A description of the computer program is presented herein along with the methods used in the digital approximations, flow charts, program code, instructions for the user, and a test case with input and output listings.

SYMBOLS

A_j coefficients in governing differential equations

a_η tangential velocity gradient

B_j	coefficients in governing differential equations
C	coefficients in governing differential equations
E_j	coefficients in governing differential equations
$G_{j,\eta}$	functions appearing in governing partial differential equations which are differentiated with respect to y
H	total enthalpy, $h + \frac{u^2 + v^2}{2}$
h	static enthalpy
$I_{j,\eta}$	functions appearing in governing partial differential equations which are differentiated with respect to x
p	pressure
Q	curvature of body, $\frac{R_B}{R_b}$
$q_{R,\eta}$	total radiation heat flux
R	universal gas constant
R_B	body radius of curvature at $x = 0$
R_b	local body radius of curvature (see fig. 1)
R_1	weighted heat flux
r	radius measured from axis of symmetry of body (see fig. 1)
r_b	normal distance from axis of symmetry to a point on body (see fig. 1)
T	temperature
U_∞	free-stream velocity
u, v	velocity components in x - and y -direction, respectively

V_R	resultant velocity
\overline{W}_{REF}	molecular weight of cold air, 28.96 g/mole
x	coordinate along body surface (see fig. 1)
y	coordinate normal to body surface (see fig. 1)
Z	compressibility factor
z	axial coordinate (see fig. 1)
δ	shock displacement distance (see fig. 1)
δ_0	value of shock displacement distance at axis of symmetry
η	transformed y-coordinate, y/δ
θ_b	body inclination angle (see fig. 1)
ρ	density
ω	shock-wave angle (see fig. 1)

Subscripts:

j	used (as first subscript) to denote a particular governing differential equation:
1	shock-geometry equation
2	continuity equation
3	x-momentum equation
4	y-momentum equation
5	energy equation
s	shock-oriented properties
stag	stagnation condition

η denotes location within shock layer:

0 body surface

1 at shock wave

∞ free-stream conditions

When double subscripts are used, the first (j) denotes the governing equation number and the second (η) denotes location within shock layer.

Primes denote dimensional quantities.

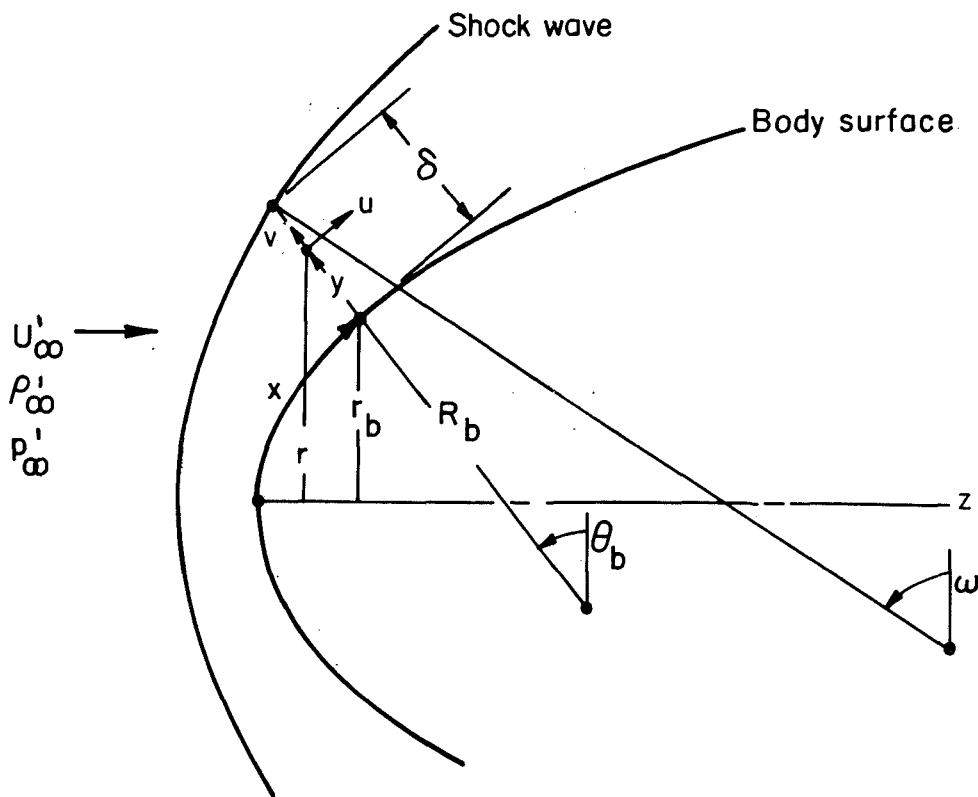


Figure 1.- Flow-field coordinate system.

PROBLEM DESCRIPTION

The equations which govern inviscid, radiating, nonadiabatic steady flow of equilibrium air over a blunt body traveling at hypersonic speeds are a system of nonlinear partial differential equations derived from the laws of conservation of mass, momentum, and energy. The modified method of integral relations, as described in reference 3, is used to transform the governing equations into a set of ordinary differential equations

that are numerically integrated to yield the details of the thermodynamic and flow properties within the shock layer. The equations appear in the form used in reference 1. A slightly different notation is used in reference 3. The ordinary differential equations which form the basis for Langley program D1250 are as follows:

$$\left. \begin{aligned} \frac{d\delta}{dx} &= -E_1 = (1 + Q\delta)\tan(\omega - \theta_b) \\ \frac{d\omega}{dx} &= \frac{-A_4 \frac{d\delta}{dx} + E_4}{B_4} \\ \frac{dI_{2,0}}{dx} &= \frac{-A_2 \frac{d\delta}{dx} + B_2 \frac{d\omega}{dx} + E_2}{C} \\ \frac{dI_{3,0}}{dx} &= u_0 \frac{dI_{2,0}}{dx} \\ \frac{dI_{5,0}}{dx} &= \frac{-A_5 \frac{d\delta}{dx} + B_5 \frac{d\omega}{dx} + E_5}{C} \end{aligned} \right\} \quad (1)$$

The equations for the fluxes of mass, momentum (in the x-direction), and energy at the body surface are

$$\left. \begin{aligned} I_{2,0} &= \rho_0 u_0 \\ I_{3,0} &= p_0 + \rho_0 u_0^2 \\ I_{5,0} &= \rho_0 u_0 H_0 \end{aligned} \right\} \quad (2)$$

The quantities have been nondimensionalized as follows:

$$\begin{aligned} x &= \frac{x'}{R'_B} & \delta &= \frac{\delta'}{R'_B} & p &= \frac{p'}{\rho'_\infty (U'_\infty)^2} \\ y &= \frac{y'}{R'_B} & \rho &= \frac{\rho'}{\rho'_\infty} & H &= \frac{H'}{(U'_\infty)^2} \\ u &= \frac{u'}{U'_\infty} & R_b &= \frac{R'_b}{R'_B} & h &= \frac{h'}{(U'_\infty)^2} \\ v &= \frac{v'}{U'_\infty} & r &= \frac{r'}{R'_B} \end{aligned}$$

where primes denote dimensional quantities.

The coefficients of the governing differential equations are developed in reference 1. The expressions for the coefficients are

$$\begin{aligned}
A_2 &= 3(I_{2,0} - I_{2,1}) + \frac{2\delta \cos \theta_b}{r_b}(I_{2,0} - I_{2,1}) \\
A_4 &= -\left(3 + \frac{2\delta \cos \theta_b}{r_b}\right)I_{4,1} \\
A_5 &= 3(I_{5,0} - I_{5,1}) + \frac{2\delta \cos \theta_b}{r_b}(I_{5,0} - I_{5,1}) \\
B_j &= \delta\left(3 + \frac{2\delta \cos \theta_b}{r_b}\right)\frac{\partial I_{j,1}}{\partial \omega} \quad (j = 2, 4, 5) \\
C &= \delta\left(3 + \frac{\delta \cos \theta_b}{r_b}\right) \\
E_1 &= \frac{-(1 + Q\delta)}{Q} \tan(\omega - \theta_b) \frac{d\theta_b}{dx} \\
E_2 &= \frac{3\delta}{r_b}(I_{2,0} + I_{2,1}) \frac{dr_b}{dx} + \delta\left(3 + \frac{2\delta \cos \theta_b}{r_b}\right) \frac{\partial I_{2,1}}{\partial \theta_b} \frac{d\theta_b}{dx} \\
&\quad - \frac{\delta^2 \sin \theta_b}{r_b}(I_{2,0} + 2I_{2,1}) \frac{d\theta_b}{dx} + 6(1 + \delta Q) \left(1 + \frac{\delta \cos \theta_b}{r_b}\right) G_{2,1} \\
E_4 &= \frac{3\delta}{r_b} I_{4,1} \frac{dr_b}{dx} + \delta\left(3 + \frac{2\delta \cos \theta_b}{r_b}\right) \frac{\partial I_{4,1}}{\partial \theta_b} \frac{d\theta_b}{dx} - \frac{2\delta^2 \sin \theta_b}{r_b} I_{4,1} \frac{d\theta_b}{dx} \\
&\quad + 6(1 + \delta Q) \left(1 + \frac{\delta \cos \theta_b}{r_b}\right) G_{4,1} - 6G_{4,0} - 3\left(\delta Q + \frac{\delta \cos \theta_b}{r_b}\right) (I_{3,0} + I_{3,1}) \\
&\quad - \frac{2\delta^2 Q \cos \theta_b}{r_b} (I_{3,0} + 2I_{3,1}) + \frac{3\delta \cos \theta_b}{r_b} (\rho_0 u_0^2 + \rho_1 u_1^2) \\
&\quad + \frac{\delta^2 Q \cos \theta_b}{r_b} (\rho_0 u_0^2 + 2\rho_1 u_1^2) \\
E_5 &= \frac{3\delta}{r_b}(I_{5,0} + I_{5,1}) \frac{dr_b}{dx} - \frac{\delta^2 \sin \theta_b}{r_b}(I_{5,0} + 2I_{5,1}) \frac{d\theta_b}{dx} \\
&\quad + \delta\left(3 + \frac{2\delta \cos \theta_b}{r_b}\right) \frac{\partial I_{5,1}}{\partial \theta_b} \frac{d\theta_b}{dx} + 6\left(1 + \frac{\delta \cos \theta_b}{r_b}\right) (1 + \delta Q) G_{5,1} + 6R_1
\end{aligned}$$

where

$$G_{2,1} = \rho_1 v_1$$

$$G_{4,0} = p_0$$

$$G_{4,1} = p_1 + \rho_1 v_1^2$$

$$G_{5,1} = \rho_1 v_1 H_1$$

$$I_{2,0} = \rho_0 u_0$$

$$I_{2,1} = \rho_1 u_1$$

$$I_{3,0} = p_0 + \rho_0 u_0^2$$

$$I_{3,1} = p_1 + \rho_1 u_1^2$$

$$I_{4,0} = 0$$

$$I_{4,1} = \rho_1 u_1 v_1$$

$$I_{5,0} = \rho_0 u_0 H_0$$

$$I_{5,1} = \rho_1 u_1 H_1$$

$$R_1 = (1 + \delta Q) \left(1 + \frac{\delta \cos \theta_b}{r_b} \right) q_{R,1} - q_{R,0}$$

Provision has been made in the governing equations for coupled radiating flow-field analysis. The radiation program, RATRAP (ref. 4), is an independent program which was incorporated into D1250 as subprograms.

The governing differential equations are solved by a fourth-order Runge-Kutta integration technique (see appendix A) to give shock-layer thickness, shock angle, and the fluxes of mass, momentum, and energy at the body surface. The numerical integration proceeds from the stagnation point ($x = 0$); however, direct substitution of the initial values into the governing differential equations at $x = 0$ results in indeterminate (0/0) expressions. (See ref. 3.) Application of L'Hospital's rule yields the proper starting values for the nonzero derivatives:

$$\left(\frac{d\omega}{dx}\right)_{x=0} = \frac{(3 + 3\delta_o + \delta_o^2)(p_{\text{stag}} - p_1 + v_1)}{\delta_o(3 + 2\delta_o)(1 - \rho_1)v_1}$$

$$\left(\frac{dI_{2,0}}{dx}\right)_{x=0} = \frac{\delta_o(3 + 2\delta_o)(1 - \rho_1)\left(\frac{d\omega}{dx}\right)_{x=0} - (3 + 3\delta_o + \delta_o^2)}{-\delta_o(3 + \delta_o)}$$

$$\left(\frac{dI_{5,0}}{dx}\right)_{x=0} = H_{\text{stag}}\left(\frac{dI_{2,0}}{dx}\right)_{x=0}$$

where

$$H_{\text{stag}} = (H_1)_{x=0} - \frac{3R_{1,\text{stag}}}{\delta_o(3 + \delta_o)\left(\frac{dI_{2,0}}{dx}\right)_{x=0}}$$

$$p_{\text{stag}} = \frac{\rho_{\text{stag}} a_{0,\text{stag}}^2}{-\beta}$$

$$R_{1,\text{stag}} = \left[(1 + \delta_o)^2 q_{R,1} - q_{R,0} \right]_{x=0}$$

and β is the input value PEEP (ref. 3, eq. (36)). These equations contain δ_o , the shock displacement distance at the axis of symmetry ($x = 0$). Since δ_o is initially assumed, a correct value has to be established for the flow-field solution. The regularity conditions at the sonic point, that is, a sonic velocity u_0 and a zero mass flux derivative $\left(\frac{dI_{2,0}}{dx} = 0\right)$, provide the convergence criteria for the proper δ_o .

A Newton-Raphson iteration technique (ref. 5) is used to obtain the set of properties on the body which are consistent with the integrated fluxes. Rankine-Hugoniot relations and the shock angle are used to compute the properties immediately behind the shock. The fluxes ρu , ρuv , and ρuH and the resultant velocity are assumed to vary linearly across the shock layer. Thus, the post-shock and the body properties along with this assumption of linear variation within the shock layer are sufficient to generate consistent velocity components and enthalpies across the entire shock layer. These quantities are computed by the following relations:

$$v_\eta = \frac{I_{4,\eta}}{I_{2,\eta}}$$

$$H_\eta = \frac{I_{5,\eta}}{I_{2,\eta}}$$

$$V_{R,\eta} = V_{R,0} + (V_{R,1} - V_{R,0})\eta$$

The pressure distribution is then calculated from the quadratic expression

$$p_\eta = p_0 + (\delta Q p_0 u_0^2)\eta + (p_1 - p_0 - \delta Q p_0 u_0^2)\eta^2$$

The remaining state properties are computed from the equilibrium-air correlations of reference 1.

The integration continues until the pressure at the body diverges, either increasing or decreasing rapidly. This divergence indicates that the sonic point on the body, which is a singular point, has been reached. An increasing divergence of the pressure indicates that the initial δ_0 was too large, and a decreasing divergence of the pressure indicates that δ_0 was too small. The program is stopped after a specified number of iterations on δ_0 or when a maximum value of x , which is an input, has been reached.

PROGRAM ORGANIZATION

D1250 Labeled COMMON

The following list contains all the FORTRAN variables appearing in labeled COMMON, except those used by the radiation package, in the order and with the dimensional information used in program D1250:

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/REAI/	IREAD	Set to 0 in EQUATS so that the NAMELIST input in MAIN will only be read the first time through MAIN
/MAINP/	AA1(6)	Coefficients used in the governing differential equations, computed in COEF
	AC	Program variable computed in MAIN
	AO	a_0

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	AOVERB	Ratio of semiminor axis to semimajor axis of an ellipse
	A1	a_1
	BB1(6)	Coefficients used in the governing differential equations, computed in COEF
	CAPH0	H_0
	CAPH1	H_1
	CAPQ	Q
	CC	Program variable computed in MAIN
	CC1	Coefficient used in the governing differential equations, computed in COEF
	CCI	Initial computing interval used by INT1
	CCUVAR(8)	Double-precision array used by INT1 to store values of independent and dependent variables at which derivatives will be evaluated in DERSUB
	CII	Initial interval away from singular point of stagnation streamline
	CIMAX	Absolute value of maximum computing interval used by INT1
	COSTB	$\cos \theta_b$
	COSW	$\cos \omega$
	CWMTB	$\cos(\omega - \theta_b)$

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	DAF	$\frac{\delta \cos \theta_b}{r_b}$ computed in DERSUB, used in COEF
	DDELDX	$\frac{d\delta}{dx}$
	DDER(8)	Array in which derivatives are stored
	DD1	Coefficient used in governing differential equations, computed in COEF
	DELL	Lower limit for δ
	DELS	δ^2
	DELTA	δ
	DEL TN	δ_0
	DELU	Upper limit for δ
	DIODX(6)	$\frac{dI_{j,0}}{dx}$
	DI1DW(6)	$\frac{\partial I_{j,1}}{\partial \omega}$ (j = 2,3,4,5)
	DOSRB	$\frac{\delta}{r_b}$ computed in DERSUB, used in COEF
	DP1DW	$\frac{dp_1}{d\omega}$
	DRBDX	$\frac{dr_b}{dx}$
	DRO1DW	$\frac{d\rho_1}{d\omega}$
	DTBDX	$\frac{d\theta_b}{dx}$
	DUSDW	$\frac{du_s}{d\omega}$
	DU1DW	$\frac{du_1}{d\omega}$

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	DVSDW	$\frac{dv_s}{d\omega}$
	DV1DW	$\frac{dv_1}{d\omega}$
	DWDX	$\frac{d\omega}{dx}$
	EELE1(7)	Relative error used by INT1
	EELE2(7)	Relative zeros, used by INT1
	EELT(3)	Values for return to program from INT1
	EE1(6)	Coefficients used in governing differential equations, computed in COEF
	EERVAL(8)	Array used by INT1
	EMUREF	\overline{W}_{REF}
	EO1	Coefficient appearing in the differential equations, computed in COEF
	EPSR	Accuracy criterion for R_1 iteration in MAIN
	EPS21	Accuracy criterion for iteration on ρ
	GGO(6) } GG1(6) }	Coefficients used in governing differential equations, computed in COEF
	HONE	H_1
	ICOSW	Control to set COSW to exactly 0 when $\omega = \frac{\pi}{2}$
	IERR	Integer value supplied by INT1 as an error code

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	IGEO	Control in GEO for body shape: 1 sphere 2 ellipsoid 3 hyperboloid
	ITEXT	Time history print option used by INT1
	ITTEST	Iteration limit in PROPIT
	KEKONT	Counter for number of iterations for δ_o
	KETEST	Number of iterations desired on δ_o
	KKKK	Radiation option: 0 do not compute radiation 1 adiabatic radiation 2 nonadiabatic radiation
	OPERA	$\frac{\sin \theta_b}{r_b}$ computed in DERSUB, used in COEF
	P	p
	PEEP	Coefficient in equation describing pressure variation in stagnation region (see ref. 3, eq. (36))
	PIN	p_∞
	PO	p_0
	PSTAG	Stagnation pressure
	P1	p_1
	QD	$Q\delta$

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	R	Universal gas constant
	RB	Body radius of curvature at axis of symmetry ($x = 0$)
	RBX	Body radius of curvature at any x-coordinate
	RHOIN	ρ_{∞}
	RHON	Initial guess for ρ
	RHOO	ρ_0
	RHO1	ρ_1
	R1	Weighted heat flux
	SINTB	$\sin \theta_b$
	SINSQW	$\sin^2 \omega$
	SINW	$\sin \omega$
	SMALLB	Semimajor axis of an ellipse, nondimensionalized with R_B
	SMALRB	r_b
	STAENT	Static enthalpy
	SSPEC	Print control used by INT1 (if SSPEC = 0, control will be returned after every acceptable integration step; if SSPEC \neq 0, control will be returned at specified increment of independent variable)
	SWMTB	$\sin(\omega - \theta_b)$
	T	T'

<u>COMMON label</u>	<u>FORTTRAN variable</u>	<u>Description</u>
/MAINP/	TCG	Accuracy criterion on iteration for ρ_0 in RANH
	TEAN	Initial guess for T'
	THETAB	θ_b
	TO	T_0
	T1	T_1
	UIN	U_∞
	UINS	U_∞^2
	UO	u_0
	US	u_s
	U1	u_1
	V	v
	VO	v_0
	VS	v_s
	V1	v_1
	VVAR(8)	Double-precision array used by INT1 which contains independent variable followed by dependent variables
	W	ω
	X	Coordinate along body surface
	XIO(6)	$I_{j,0}$ (j = 2,3,4,5)

<u>COMMON</u> <u>label</u>	<u>FORTTRAN</u> <u>variable</u>	<u>Description</u>
/MAINP/	XI1(6)	$I_{j,1}$
	XMAX	Maximum value of x allowed
	Z1	z_1
	ZO	z_0
/QQQ/	QI1 QI2 QO1 QO2	} Curve-fit coefficients to radiation distribution around body, used for all but final δ_0 iteration
	QRY1	Total radiation heat flux at shock
	QRYO	Total radiation heat flux at body
	QSTAG	Stagnation heat flux

The following table is a cross-reference between labeled COMMON and D1250 subprograms (where X denotes labeled COMMON appearing in each subprogram and the radiation labeled COMMON blocks are WON, RAD, AAA, CIONCL):

Subprogram	COMMON label						
	REAI	MAINP	QQQ	WON	RAD	AAA	CIONCL
EQRATS	X						
MAIN	X	X	X		X	X	X
RANH		X					
GEO		X					
FIRST		X					
THEP							
THER							
CONT		X	X				
CHER		X					
PROFIT							
COEF		X					
CALD		X					
DERSUB		X					
CHSUB							
PROD		X		X	X	X	X
FOFX		X					
RADFLUX		X		X	X	X	X
LINE				X	X	X	X
CONTM				X	X	X	X
MU							
FEMP					X	X	X
DEFIOJ							
ORDERI							
ORDERV							
INVERT							
EQUIL					X	X	X
CHGBAL					X	X	X
ZHV							
LTP					X	X	X
HAFACE							
DTLNEQ							
HTP					X	X	X
TRAP1							
FLUT							
INOCAL					X	X	X
TRAP							
MASBAL							

D1250 Subprogram Descriptions, Flow Charts, and Listings

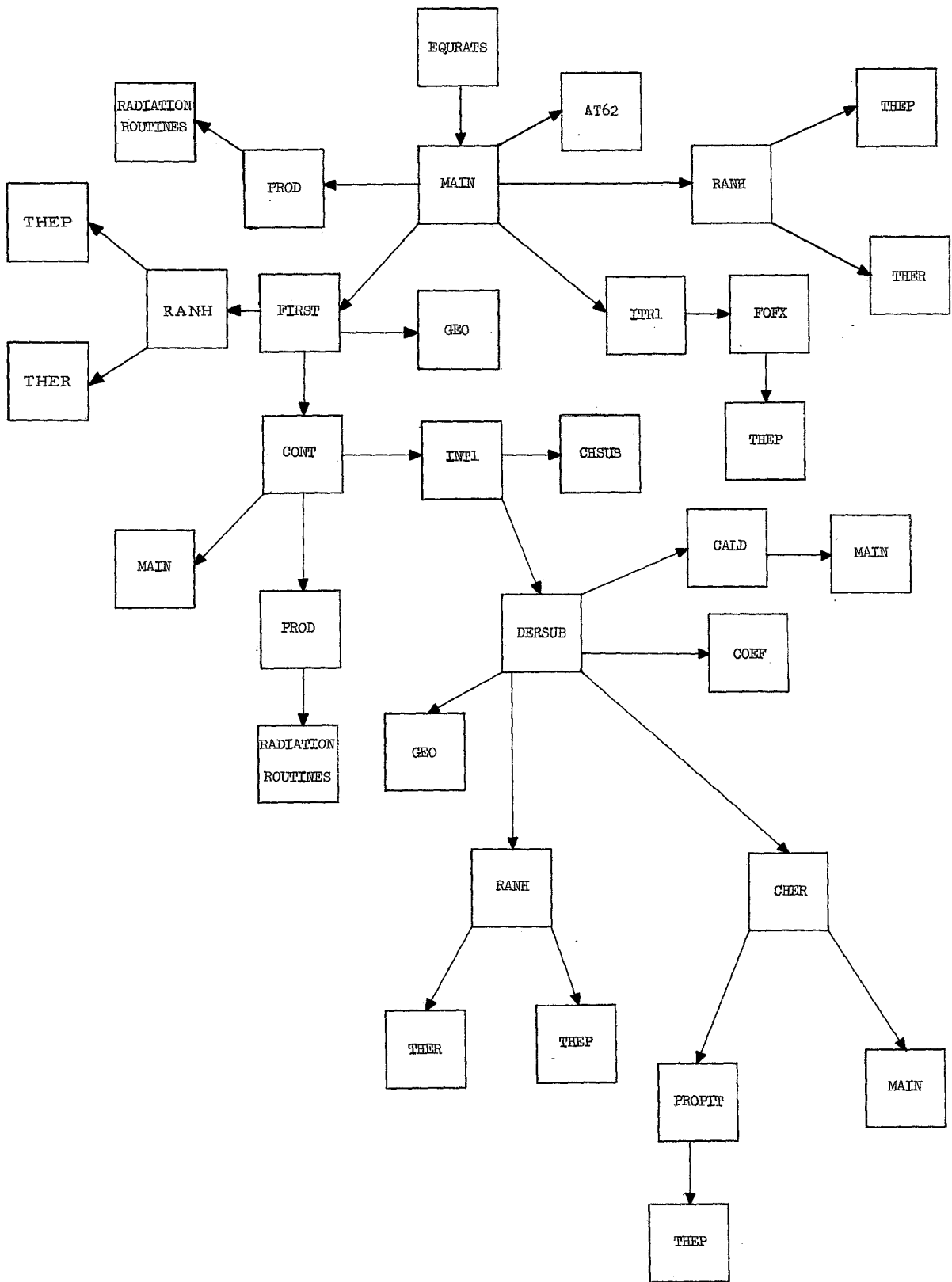
Langley program D1250 is one of a series of programs developed to analyze blunt-body flow-field data by the method of integral relations. Since many of the same computational methods were used in the various flow-field programs, each procedure was written as an independent subprogram to be called as needed. The radiation subprograms form an independent program (ref. 4) which has been added to D1250.

This section of the report presents a brief description of the subprograms used, a statement of the function of each subprogram, individual flow charts, and subprogram listings. Listings of the radiation subprograms are also included. A list of each subprogram and its description is given as follows:

<u>Subprogram</u>	<u>Description</u>
EQURATS	Writes program title and calls MAIN
MAIN	Reads and writes NAMELIST input, EQRAD, initializes program variables, and computes stagnation-streamline solution
RANH	Calculates post-shock conditions by use of Rankine-Hugoniot equations
GEO	Computes body geometry
FIRST	Computes properties at first step off stagnation line
THEP	Thermodynamics routine which solves correlation equation for equilibrium air
THER	Calculates partial derivatives of equilibrium-air properties
CONT	Calls integration routine, performs iteration on δ_0 for sphere-pressure results, and writes output
CHER	Performs an additional test on δ_0 iteration
PROPIT	Iteration subroutine for body properties
COEF	Calculates coefficients of governing differential equations

<u>Subprogram</u>	<u>Description</u>
CALD	Computes governing differential equations which are used in DERSUB
DERSUB	Called by Runge-Kutta integration routine INT1 to evaluate the derivatives
CHSUB	Called by INT1 to allow the user certain logical control
FOFX	A function subprogram called by ITR1 for p_0 (p_{stag}) iteration
PROD	Reads and writes NAMELIST input for radiation subprograms, calls subprograms to compute radiation, and computes thermodynamic properties within shock layer

A directed graph of the FORTRAN subprograms used in D1250 is given in the flow chart on the following page.



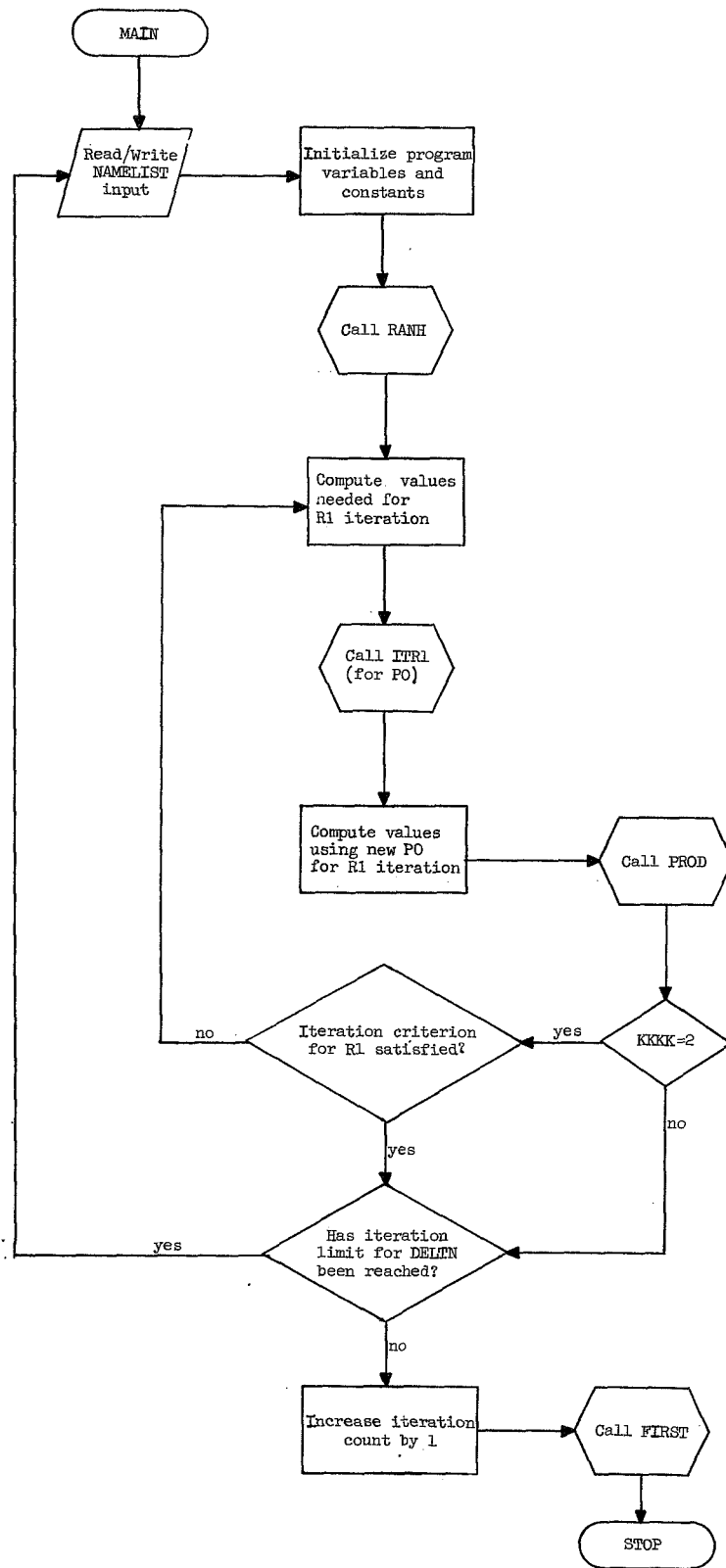
EQRATS

EQRATS writes the program identification and calls MAIN.

	PROGRAM EQRATS(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,PUNCH)	A	1
C		A	2
C		A	3
C	EQUILIBRIUM WITH RADIATION PROGRAMED BY FRANCES W. TAYLOR	A	4
C		A	5
	COMMON /REAI/ IREAD	A	6
	WRITE (6,1)	A	7
	IREAD=0	A	8
	CALL MAIN	A	9
	STOP	A	10
C		A	11
C		A	12
1	FORMAT (1H120X58HEQUILIBRIUM WITH RADIATION PROGRAMED BY FRANCES	A	13
	1W. TAYLOR/)	A	14
	END	A	15-

MAIN

The function of subprogram MAIN is to call the NAMELIST input, EQRAD, to initialize the program, and to compute the stagnation-line solution. The stagnation-line solution is obtained by an iteration on p_0 (in MAIN $p_0 = p_{\text{stag}}$) by using the library routine ITR1. The program is ended either after a specific number of iterations on δ_0 , which is controlled by the input KETEST, or when a maximum value of x has been reached. The flow chart for subprogram MAIN is as follows:



	SUBROUTINE MAIN	B	1
	DOUBLE PRECISION VVAR,CCUVAR	B	2
C		B	3
C		B	4
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPHD,CAPH1,CAPQ,CC,C	B	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTR,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	B	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	B	7
	3D1DW,DTBDX,DUSOW,DUIOW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	B	8
	4EE1(6),ERRVAL(7),EMUREF,EQ1,EPSR,EPS21,GG0(6),GG1(6),HUNE,ICOSW,IE	B	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	B	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	B	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TD,T1,UIN,UINS,UO,US,U1,	B	12
	8V,VO,VS,V1,VVAR(8),W,X,XI0(6),XI1(6),XMAX,Z0,Z1	B	13
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	B	14
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	B	15
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	B	16
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	B	17
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	B	18
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	B	19
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	B	20
	COMMON /RAD/ XNN(7,100)	B	21
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	B	22
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	B	23
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	B	24
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	B	25
	1HVM(20),FHVP(20)	B	26
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	B	27
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	B	28
	COMMON /REAL/ IREAD	B	29
	COMMON /QQQ/ QI1,QI2,QQ1,QQ2,QRY1,QRY0,QSTAG	B	30
	DIMENSION ANS(4)	B	31
	EXTERNAL FOFX	B	32
	NAMelist /EQRAD/ ALT,AOVERB,CCI,CII,CIMAX,DELTX,DUMBTIM,FELE1,EFLE	B	33
	12,EELT,EITR1,EITR2,EMUREF,EPSR,EPS21,IALT,IGEO,ITEXT,ITTEST,KETEST	B	34
	2,KKKK,PEEP,PIN,QI1,QI2,QQ1,QQ2,R,RB,RHON,RHOIN,R1,SSPEC,TEAN,TCG,U	B	35
	3IN,XMAX	B	36
C	ALT	B	37
C	AOVERB	B	38
C	CCI	B	39
C	CIMAX	B	40
C	CII	B	41
C	DELTX	B	42
	ALTITUDE FOR AT62		
	A BODY GEOMETRY PARAMETER		
	INITIAL COMPUTING INTERVAL		
	ABSOLUTE VALUE OF MAXIMUM COMPUTING INTERVAL USED BY INT1		
	INITIAL LINEAR INTEGRATION STEP IN FIRST		
	INITIAL GUESS		
	USED IN ITR1		

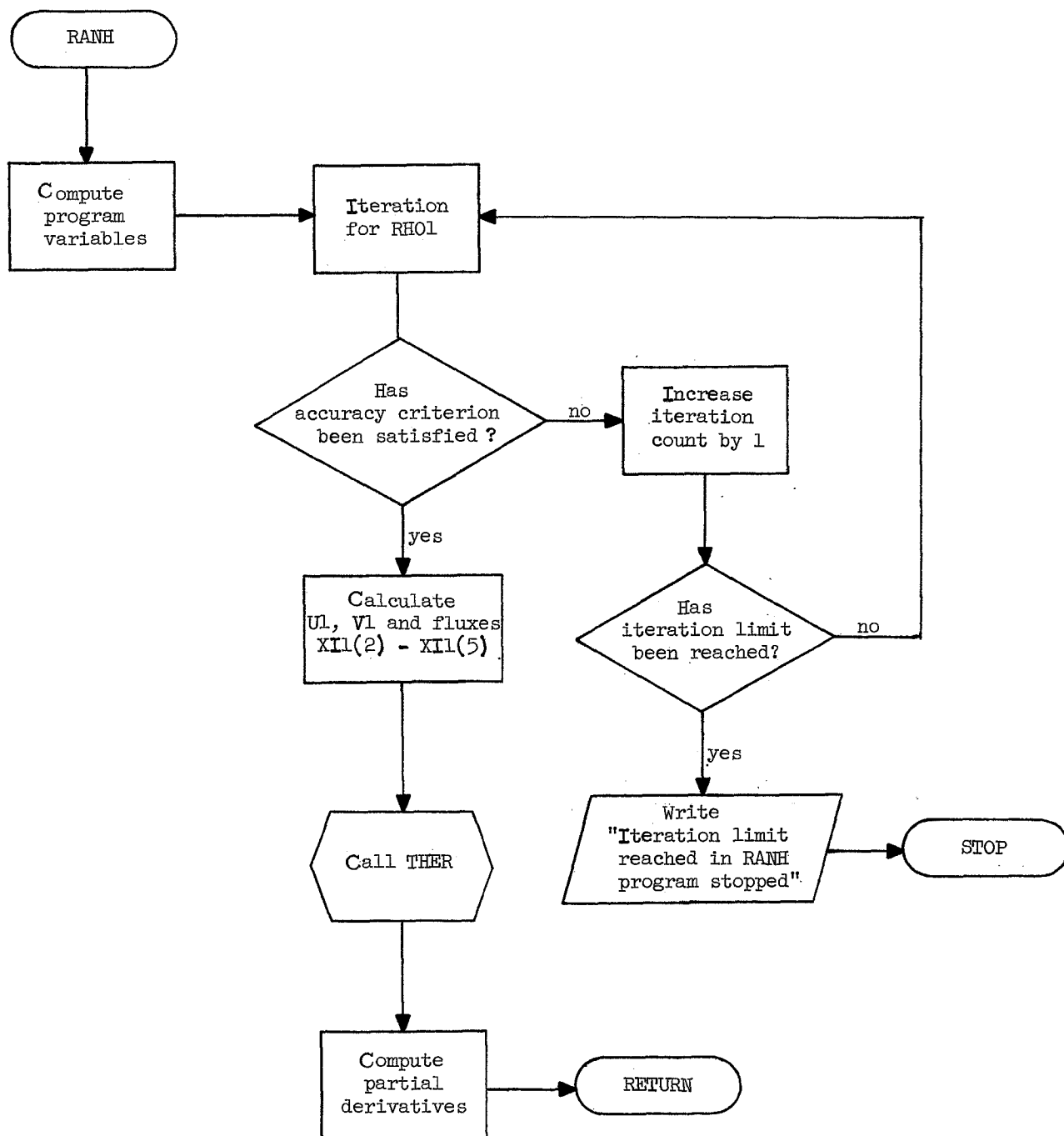
C	EELE1	RELATIVE ERROR	USED BY INT1	B	43
C	EELE2	RELATIVE ZERO	USED BY INT1	B	44
C	EELT	VALUE FOR RETURN TO PROGRAM	USED BY INT1	B	45
C	EITR1	RELATIVE ERROR	USED IN ITR1	B	46
C	EITR2	ABSOLUTE ERROR	USED IN ITR1	B	47
C	EMUREF	MOLECULAR WEIGHT OF COLD AIR	USED IN THEP	B	48
C	EPSR	ACCURACY FOR R1 ITERATION IN MAIN		B	49
C	EPS21	ACCURACY FOR RHO ITERATION IN PROPIT		B	50
C	IALT	=1 CALL AT62		B	51
C	IGEO	A TEST IN GEO FOR SPHERE, ELLIPSOID OR HYPERBOLOID		B	52
C	ITEXT	TIME HISTORY PRINT OPTION =0 NO PRINTOUT	USED BY INT1	B	53
C	ITTEST	ITERATION LIMIT USED IN PROPIT		B	54
C	KETEST	THE NUMBER OF PASSES THROUGH MAIN		B	55
C	KKKK	IF 0 NO RADIATION, IF 1 ADIABATIC RADIATION IS COMPUTED		B	56
C		IF 2 NONADIABATIC RADIATION IS COMPUTED		B	57
C	PEEP	PRESSURE VARIATION COEFFICIENT		B	58
C	PIN	FREE STREAM PRESSURE		B	59
C	R	GAS CONSTANT		B	60
C	RB	BODY RADIUS		B	61
C	RHOIN	FREE STREAM DENSITY		B	62
C	RHON	INITIAL VALUE OF RHO		B	63
C	R1	INITIAL GUESS FOR WEIGHTED HEAT FLUX		B	64
C	SSPEC	PRINT CONTROL	USED BY INT1	B	65
C	TCG	ACCURACY ON ITERATION FOR DENSITY IN RANH		B	66
C	TEAN	INITIAL VALUE OF T		B	67
C	UIN	FREE STREAM VELOCITY		B	68
C	XMAX	WHEN X=XMAX THE PROGRAM IS STOPPED		B	69
C				B	70
	XLAST=X			B	71
	IREAD=IREAD+1			B	72
	IF (IREAD-1) 1,1,3			B	73
1	READ (5,EQRAD)			B	74
	IF (EOF,5) 10,2			B	75
2	WRITE (6,EQRAD)			B	76
	III=0			B	77
	KEKONT=0			B	78
	IF (IREAD.EQ.1) IPROD=0			B	79
	IREAD=IREAD+1			B	80
	R2=R1			B	81
3	KEKONT=KEKONT+1			B	82
	IF (KEKONT.GT.KETEST) GO TO 1			B	83
	IF (KKKK.NE.2) R1=0			B	84
	IF (III.NE.0) GO TO 4			B	85

	IF (IALT.NE.1) GO TO 4	B 86
	CALL AT62 (ALT,ANS)	B 87
	PIN=ANS(2)*478.80258	B 88
	RHOIN=ANS(1)*.515379	B 89
	WRITE (6,11) RHOIN,PIN	B 90
4	X=0	B 91
	W=3.1415927/2.	B 92
	THETAB=3.1415927/2.	B 93
C		B 94
C	ICOSW IS 0 WHEN COS(W)=0 ICOSW=1 COS(W) IS COMPUTED	B 95
C		B 96
	ICOSW=0	B 97
	UINS=UIN**2	B 98
	DRBDX=1.	B 99
	DTBDX=-1.	B 100
	SMALRB=0	B 101
	RBX=1.	B 102
	CAPQ=1.	B 103
	T=TEAN	B 104
	CALL RANH	B 105
	IF (III.NE.0) GO TO 5	B 106
	R078=DUMBTIM/RHO1	B 107
	DELU=1.1*R078	B 108
	DELL=.8*R078	B 109
5	III=III+1	B 110
	DELTN=(DELL+DELU)/2.	B 111
	DELTA=DELTN	B 112
	QD=CAPQ*DELTA	B 113
	WRITE (6,12) DELTN,XLAST	B 114
	TWODEL=2.*DELTA	B 115
	THRDEL=3.*DELTA	B 116
	DELS=DELTA**2	B 117
	AC=(3.+THRDEL+DELS)/V1	B 118
	BC=DELTA*(3.+TWODEL)	B 119
	CC=DELTA*(3.+DELTA)	B 120
	UO=0	B 121
	VO=0	B 122
	SINTB=1.	B 123
	DIM=2.*DELTA*SINTB/DRBDX	B 124
6	PO=P1+.5*RHO1*V1**2	B 125
	R1=R2	B 126
	CALL ITR1 (PO,DELTX,FOFX,EITR1,EITR2,100,ICODE)	B 127
	IF (ICODE.GT.0) WRITE (6,13) ICODE	B 128

	P1MPO=P1-PO	B 129
	RHOQ=- (AC**2*P1MPO**2)/(PEEP*CC**2*PO)	B 130
	CAPHQ=CAPH1-(3.*R1)/(AC*P1MPO)	B 131
	RHOQAO=(AC*P1MPO)/CC	B 132
	DWDX=AC*(PO-P1+V1)/(BC*(1.-RHO1))	B 133
	A1=(DWDX*(1.-RHO1)+1.)/RHO1	B 134
	AO=RHOQAO/RHOQ	B 135
	DELTD=DELTA*RB	B 136
	USTAR=0	B 137
	IF (KEKONT.EQ.KETEST) WRITE (6,14) UD,RHOQ,AO,RHOQAO,CAPHQ,PO,DWDX	B 138
	1,DELTD,DELTA	B 139
	IPROD=IPROD+1	B 140
C		B 141
C	IF KKKK=0 THE RADIATION IS NOT COMPUTED, KKKK=1 ADIABATIC	B 142
C	RADIATION IS COMPUTED, KKKK=2 FOR NONADIABATIC RADIATION	B 143
C		B 144
	CALL PROD (USTAR,IPROD,AO,A1,QRYO,QR1)	B 145
	IF (KKKK.NE.2) GO TO 9	B 146
	R1P=(1.+DELTA)**2*QR1-QRYO	B 147
	ABR=ABS((R1P-R1)/R1P)	B 148
	IF (ABR-EPSR) 8,8,7	B 149
7	R2=R1P	B 150
	GO TO 6	B 151
C		B 152
C	KEKONT COUNTS THE NUMBER OF PASSES THRU MAIN	B 153
C		B 154
C		B 155
C	TEST FOR NEXT TO LAST TIME	B 156
C		B 157
8	IF ((KETEST-KEKONT).NE.1) GO TO 9	B 158
	QSTAG=1.E-7*QR1*RHOIN*UINS*UIN	B 159
9	DELTA=(DELU+DELL)/2.	B 160
	PSTAG=PO	B 161
	CALL FIRST	B 162
10	STOP	B 163
C		B 164
C		B 165
11	FORMAT (1H06X4HAT626X5HRHOINE15.8,6X3HPINE15.8)	B 166
12	FORMAT (1H06X5HDELTNE15.8,6X1HXE15.8)	B 167
13	FORMAT (1H06X6HICODE=I4,10X27H ITERATION DID NOT CONVERGE)	B 168
14	FORMAT (1H15X27HSTAGNATION POINT CONDITIONS6X2HUQE15.8,4X4HRHOQE15	B 169
	1.8,6X2HAQE15.8/35X6HRHOQAE15.8,6X2HHQE15.8,6X2HPOE15.8,4X4HDWDXE1	B 170
	25.8/6X24HSHOCK STAND-OFF DISTANCE5X5HDELTE15.8,1X8HDELTA/RBE15.8/	B 171
	3)	B 172
	END	B 173-

RANH

RANH computes the post-shock conditions (properties, fluxes, and partial derivatives with respect to ω) with the use of the Rankine-Hugoniot equations. It is called by MAIN for the stagnation-line solution and then by DERSUB in each integration step. The flow chart for subprogram RANH is as follows:

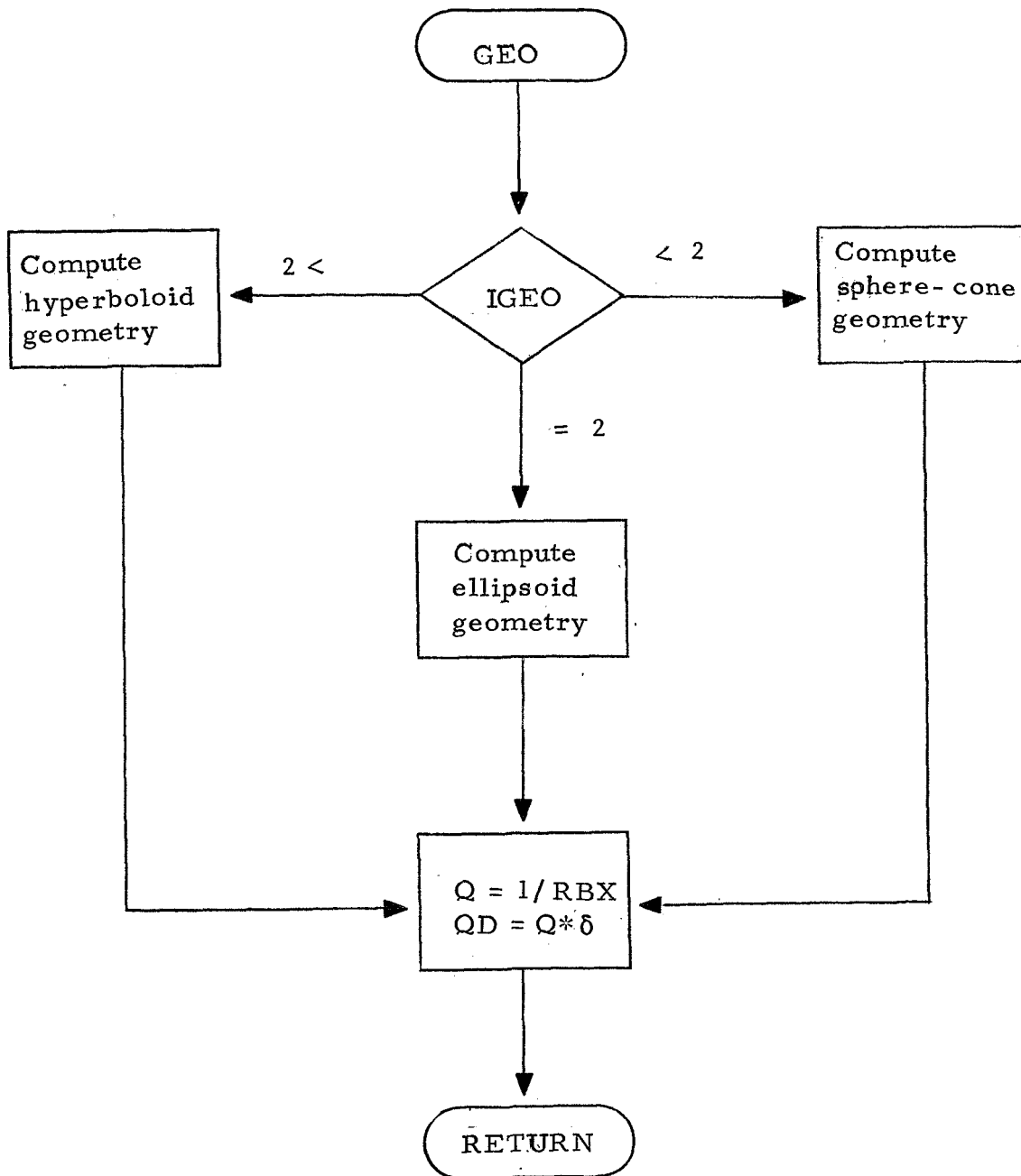


	SUBROUTINE RANH	C	1
	DOUBLE PRECISION VVAR,CCUVAR	C	2
C		C	3
C		C	4
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPH0,CAPH1,CAPQ,CC,C	C	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	C	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIDDX(6),DIIDW(6),DOSRB,DPIOW,DRBDX,DR	C	7
	301DW,DTBDX,DUSDW,DUIDW,DVSDW,DVIDW,DWDX,EELE1(7),EELE2(7),EELT(3),	C	8
	4EE1(6),ERRVAL(7),EMUREF,E01,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	C	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	C	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOD,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	C	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIN,UINS,UO,US,U1,	C	12
	8V,VO,VS,V1,VVAR(8),W,X,XID(6),XI1(6),XMAX,ZO,Z1	C	13
C		C	14
C	RANKINE HUGONIOT RELATIONS FOR EQUILIBRIUM COMPOSITION	C	15
C		C	16
	IRHO=0	C	17
	DTBDW=0	C	18
	SINW=SIN(W)	C	19
	IF (ICOSW) 1,1,2	C	20
1	COSW=0	C	21
	SWMTB=0	C	22
	GO TO 3	C	23
2	COSW=COS(W)	C	24
	SWMTB=SIN(W-THETAB)	C	25
3	CWMTB=COS(W-THETAB)	C	26
	SWS=SINW**2	C	27
	US=COSW	C	28
	RH01=RHON	C	29
4	VS=-SINW/RH01	C	30
	CAPH1=.5+3.5*PIN/(RHOIN*UINS)	C	31
	HONE=CAPH1	C	32
	STAENT=CAPH1-(US**2+VS**2)/2.	C	33
	CALL THEP (R,P1,RH01,T1,Z1,STAENT,EMUREF,PIN,RHOIN,UINS,KEZ)	C	34
	RH01P=(PIN/(RHOIN*UINS)+SWS-P1)/VS**2	C	35
	FRH01=RH01-RH01P	C	36
	DELRO1=.1	C	37
	RH01D=RH01+DELRO1	C	38
	VP=-SINW/RH01D	C	39
	STAP=CAPH1-(US**2+VP**2)/2.	C	40
	CALL THEP (R,PD,RH01D,TX,ZX,STAP,EMUREF,PIN,RHOIN,UINS,KEZ)	C	41
	RH01DP=(PIN/(RHOIN*UINS)+SWS-PD)/VP**2	C	42

	FPRHO1=(RHO1D-RHO1DP-FRHO1)/DELRO1	C	43
	AFMFP=ABS(FRHO1/FPRHO1)	C	44
	IF (AFMFP-TCG) 6,6,5	C	45
5	RHO1=RHO1-FRHO1/FPRHO1	C	46
	IF (IRHO.GT.ITTEST) GO TO 7	C	47
	IRHO=IRHO+1	C	48
	GO TO 4	C	49
6	U1=US*CWMTB-VS*SWMTB	C	50
	V1=US*SWMTB+VS*CWMTB	C	51
	XI1(2)=RHO1*U1	C	52
	XI1(3)=P1+RHO1*U1**2	C	53
	XI1(4)=RHO1*U1*V1	C	54
	XI1(5)=RHO1*U1*CAPH1	C	55
	XI1(1)=0	C	56
	CALL THER (R,P1,RHO1,T1,Z1,STAENT,EMUREF,PIN,RHOIN,UINS,C1P,C2P,C1	C	57
	1D,C2D)	C	58
	DRO1DW=SINW*COSW*(C1D*(1.-1./RHO1**2)-2.*(1.-1./RHO1))/((SWS/RHO1*	C	59
	1*2)*(1.-C1D/RHO1)-C2D)	C	60
	DSH1DW=SINW*COSW*(1.-1./RHO1**2)+SWS/RHO1**3*DRO1DW	C	61
	DP1DW=C1D*DSH1DW+C2D*DRO1DW	C	62
	DUSDW=-SINW	C	63
	DVSDW=-1./RHO1*(US+VS/RHO1*DRO1DW)	C	64
	DU1DW=DUSDW*CWMTB-DVSDW*SWMTB-US*SWMTB*(1.-DTBDW)-VS*CWMTB*(1.-DTB	C	65
	1DW)	C	66
	DV1DW=DUSDW*SWMTB+DVSDW*CWMTB+US*CWMTB*(1.-DTBDW)-VS*SWMTB*(1.-DTB	C	67
	1DW)	C	68
	DI1DW(2)=RHO1*DU1DW+U1*DRO1DW	C	69
	DI1DW(3)=DP1DW+2.*RHO1*U1*DU1DW+U1**2*DRO1DW	C	70
	DI1DW(4)=RHO1*V1*DU1DW+RHO1*U1*DV1DW+U1*V1*DRO1DW	C	71
	DI1DW(5)=CAPH1*DI1DW(2)	C	72
	RETURN	C	73
7	WRITE (6,8)	C	74
	STOP	C	75
C		C	76
C		C	77
8	FORMAT (1H06X39HITERATION LIMIT IN RANH PROGRAM STJPPED)	C	78
	END	C	79-

GEO

Subprogram GEO computes the body geometry. The user has a choice of three body shapes which are controlled by an input IGEO. IGEO = 1 computes sphere geometry, IGEO = 2 computes ellipsoid geometry, and IGEO = 3 computes hyperboloid geometry. GEO is called by FIRST for the stagnation-line solution and by DERSUB for each integration step. The flow chart for subprogram GEO is as follows:

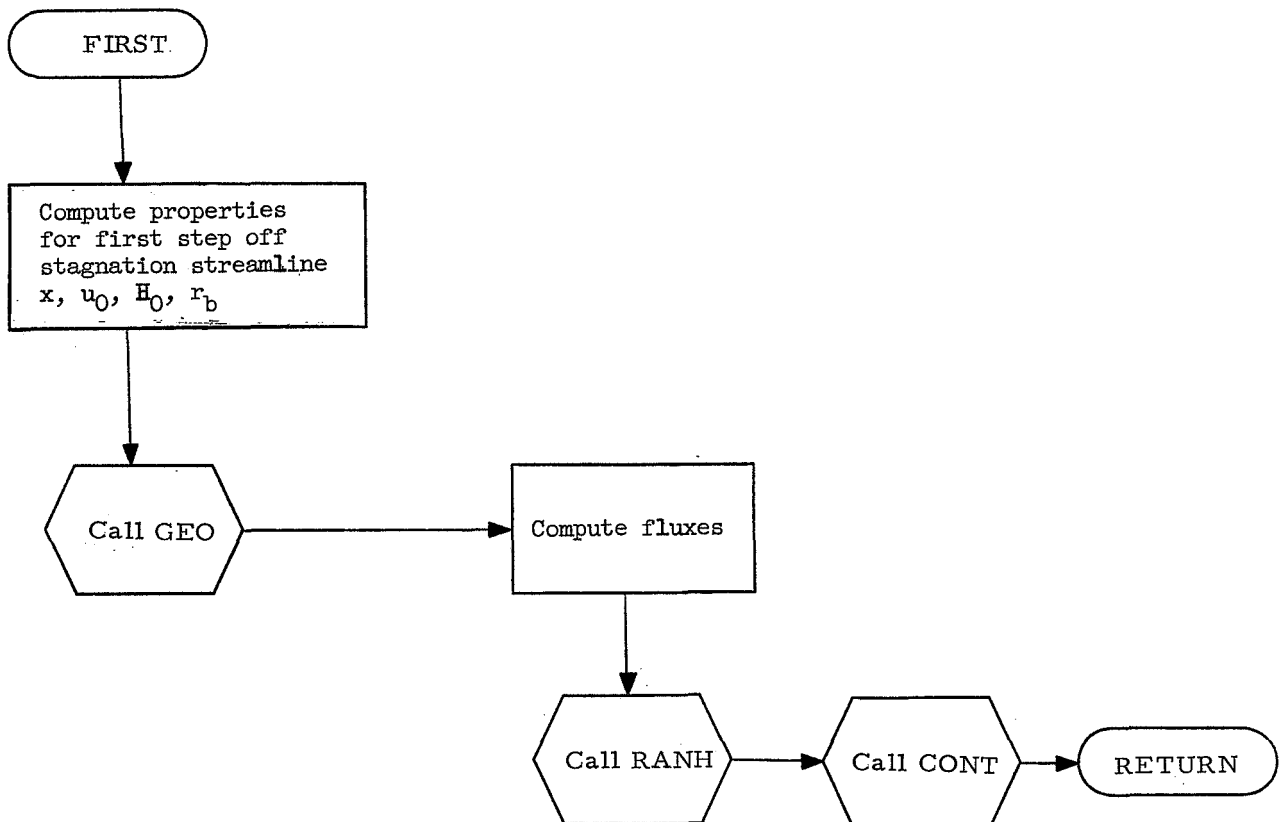


	SUBROUTINE GEO	F	1
C		F	2
	DOUBLE PRECISION VVAR,CCUVAR	F	3
C		F	4
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPHQ,CAPH1,CAPQ,CC,C	F	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	F	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	F	7
	301DW,DTBDX,DUSDW,DUI1DW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	F	8
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	F	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,K<KK,OPERA,P,PEEP,PIN,PO,PSTAG,	F	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RHO1,R1,SINTB,SINSQW,SINW,SMALLB,SM	F	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UIINS,UO,US,U1,	F	12
	8V,VO,VS,V1,VVAR(8),W,X,X10(6),X11(6),XMAX,ZO,Z1	F	13
C		F	14
C	IGEO=1 COMPUTE SPHERE GEOMETRY IGEO=2 COMPUTE ELLIPSOID GEOMETR	F	15
C	IGEO=3 COMPUTE HYPERBOLOID GEOMETRY	F	16
C		F	17
	SMALLB=AOVERB	F	18
	IF (IGEO-2) 1,2,3	F	19
C		F	20
C	SPHERE - CONE	F	21
C		F	22
C		F	23
1	SMALRB=SIN(X)	F	24
	THETAB=3.14159265/2.-X	F	25
	DRBDX=COS(X)	F	26
	DTBDX=-1.	F	27
	RBX=1.	F	28
	GO TO 4	F	29
C	ELLIPSIOD	F	30
2	BSQ=SMALLB**2	F	31
	RSQ=SMALRB**2	F	32
	BSMRS=BSQ-RSQ	F	33
	RACE=RSQ/BSMRS	F	34
	ZB=AOVERB*SMALLB-AOVERB*SQRT(BSMRS)	F	35
	AAA=AOVERB*SMALLB	F	36
	PTAN=((SMALLB/AAA)*(AAA-ZB))/(SQRT(2.*AAA*ZB-ZB**2))	F	37
	THETAB=ATAN(PTAN)	F	38
	RBX=((1.+AOVERB**2*RACE)**(3./2.))/(AOVERB/SQRT(BSMRS)*(1.+RACE))	F	39
	CAPQ=1./RBX	F	40
	DTBDX=-CAPQ	F	41
	GO TO 4	F	42

C	HYPERBOLOID	F	43
C		F	44
3	BSQ=SMALLB**2	F	45
	RSQ=SMALRB**2	F	46
	BSPRS=BSQ+RSQ	F	47
	RACH=RSQ/BSPRS	F	48
	AAA=AOVERB*SMALLB	F	49
	SQBSPRS=SQRT(BSPRS)	F	50
	ZB=-AAA+AOVERB*SQBSPRS	F	51
	PTAN=SQBSPRS/(AOVERB*SMALRB)	F	52
	THETAB=ATAN(PTAN)	F	53
	RBX=((1.+AOVERB**2*RACH)**(3./2.))/(AOVERB/SQBSPRS*(1.-RACH))	F	54
4	CAPQ=1./RBX	F	55
	QD=CAPQ*DELTA	F	56
	RETURN	F	57
	END	F	58-

FIRST

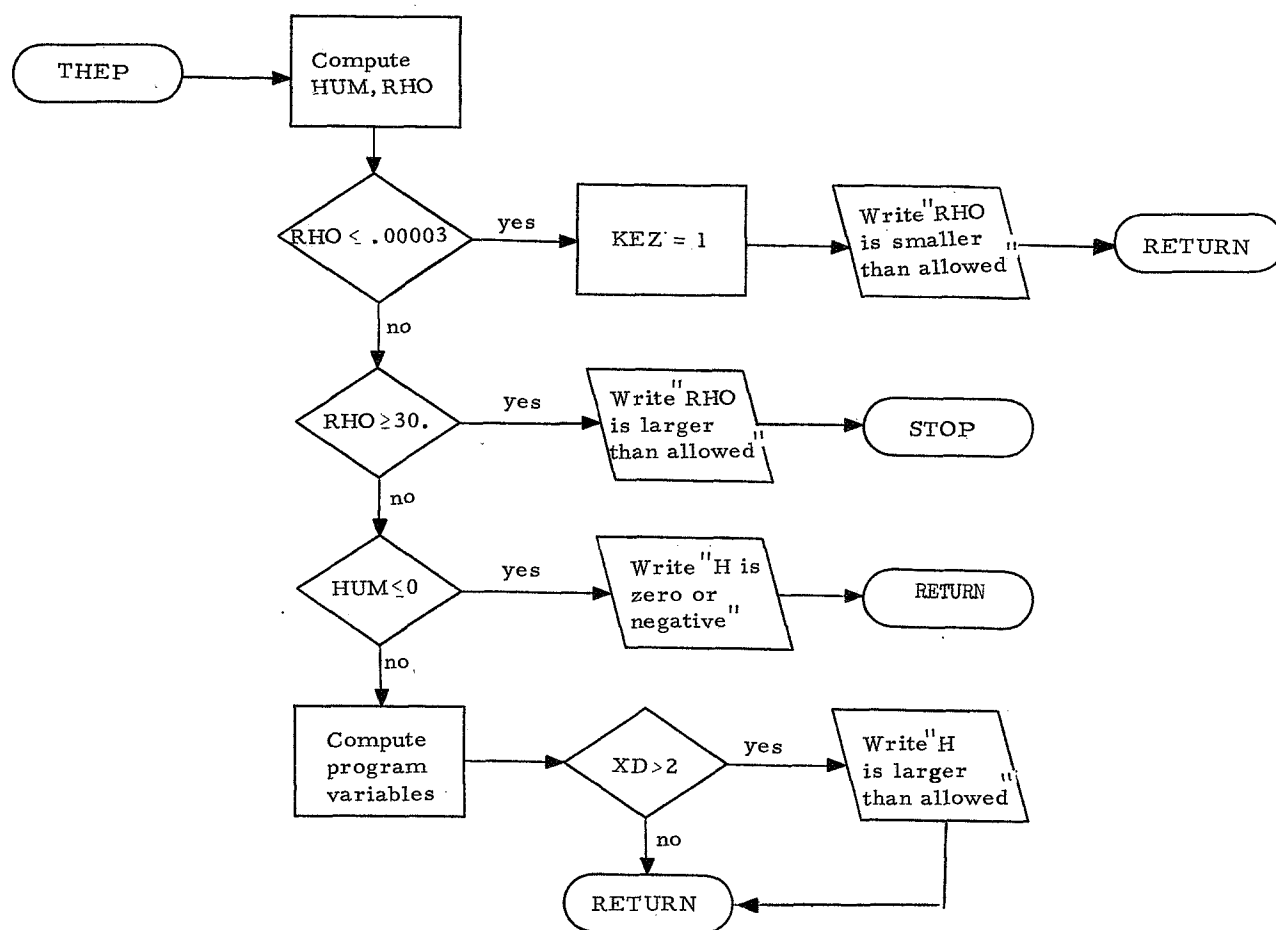
Subprogram FIRST is used to compute the properties at the first step off the stagnation line. The integration cannot start at the stagnation point since it is a singular point. The flow chart for subprogram FIRST is as follows:



	SUBROUTINE FIRST	L	1
	DOUBLE PRECISION VVAR,CCUVAR	L	2
C		L	3
C		L	4
	COMMON /MAINP/ AA1(6),AC,AO,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	L	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	L	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	L	7
	3O1DW,DTBDX,DUSDW,DUIDW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	L	8
	4EE1(6),ERRVAL(7),EMUREF,EQ1,EPSR,EPS21,GGQ(6),GG1(6),HONE,ICOSW,IE	L	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	L	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOD,RHO1,R1,SINTB,SINSQW,SINW,SMALLB,SM	L	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	L	12
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	L	13
		L	14
C	X=CII	L	15
	ICOSW=1	L	16
	UO=AO*CII	L	17
	W=W+DWDX*CII	L	18
	CAPHO=CAPHO+UO**2/2.	L	19
	SMALRB=CII	L	20
	CALL GEO	L	21
	THETAB=3.14159265/2.+DTBDX*CII	L	22
	DELTA=DELTA-((1.+QD)/CAPQ)*(W-THETAB)*DTBDX*CII	L	23
	XIO(3)=PO+RHOO*UO**2	L	24
	XIO(4)=RHOO*VO*UO	L	25
	XIO(5)=RHOO*UO*CAPHO	L	26
	XIO(2)=RHOO*UO	L	27
1	CALL RANH	L	28
	CALL CONT	L	29
	RETURN	L	30
	END	L	31-

THEP

THEP is the thermodynamics routine that solves the correlation equations for equilibrium air (ref. 1). THEP is called by RANH, PROPIT, and FOFX. It has a calling sequence in which R, EMUREF, and the free-stream conditions PIN, RHOIN, and UINS are constants. The values of density RHODUM and static enthalpy STAENT are given at the particular point at which THEP is called. The corresponding pressure PDUM, temperature TDUM, and compressibility ZDUM are calculated. There is an indicator KEZ which is set to 1 if "RHO IS SMALLER THAN ALLOWED." This is only used in PROPIT. When KEZ = 1, PROPIT returns immediately to CHER. CHER then sets DELL = DELTN and calls MAIN. The program starts again with a new δ_0 . The flow chart for sub-program THEP is as follows:

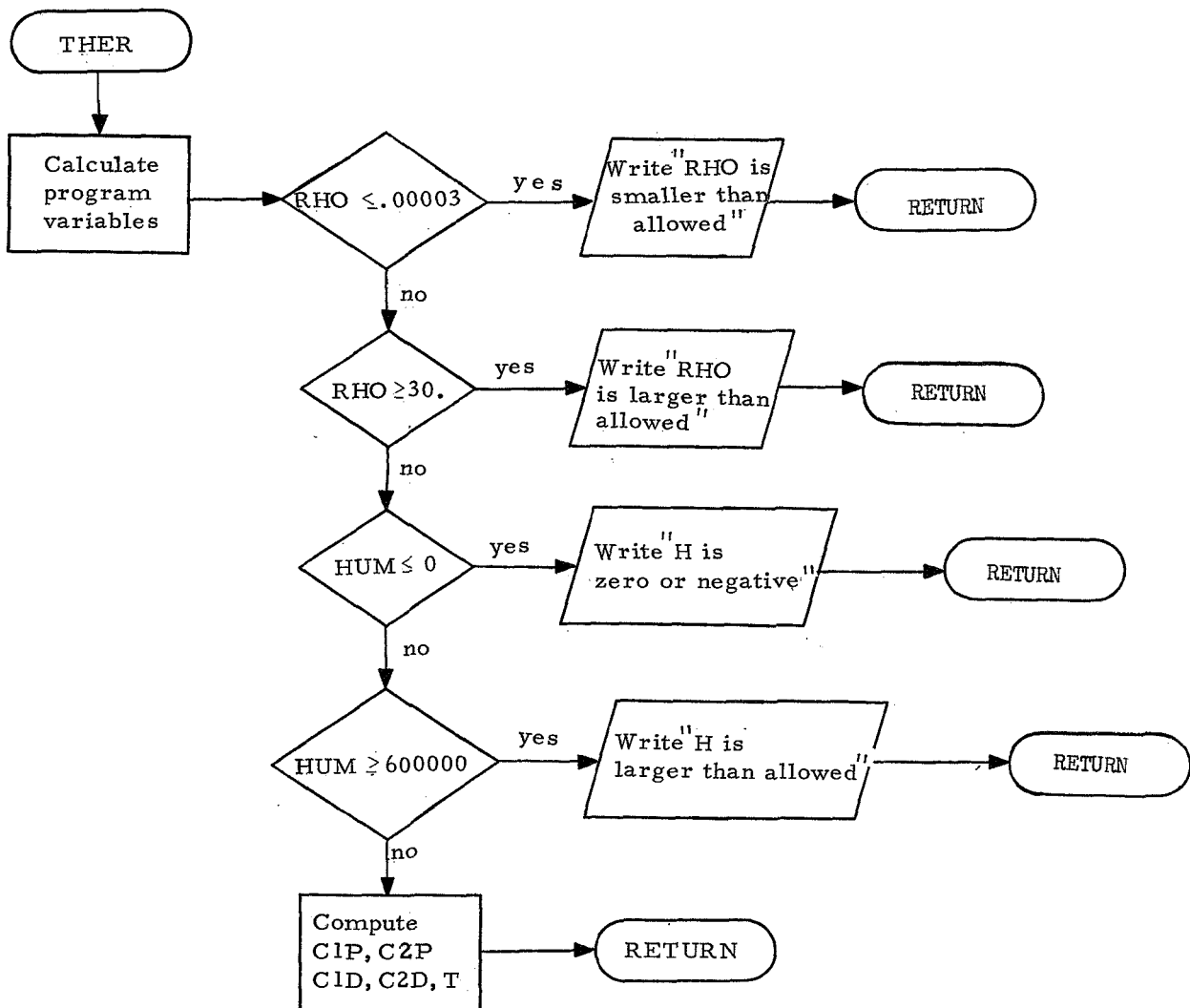


	SUBROUTINE THEP (R,PDUM,RHODUM,TDUM,ZDUM,STAENT,EMUREF,PIN,RHOIN,U	K	1
	1INS,KEZ)	K	2
C		K	3
C		K	4
C	KEZ WAS ADDED TO PROGRAM 12-14-67	K	5
C	IF RHO IS SMALLER THAN ALLOWED OR HH IS 0 OR NEG. WHEN THEP IS	K	6
C	CALLED FROM PROFIT KEZ=1 AND THE PROGRAM RETURNS TO CHER	K	7
C	IN CHER DELL=DELTN MAIN IS CALLED	K	8
C		K	9
C		K	10
	KEZ=0	K	11
	HUM=EMUREF*UINS*STAENT/R	K	12
	RHO=RHOIN/1.29313E-3*RHODUM	K	13
	IF (RHO.LE..00003) GO TO 11	K	14
	IF (RHO.GE.30.) GO TO 13	K	15
	IF (HUM.LE.0.) GO TO 10	K	16
	IF (HUM.GT.5800.) GO TO 1	K	17
	P=(.975134E-3)*HUM*RHO	K	18
	Z=1.0	K	19
	GO TO 9	K	20
1	IF (HUM.GT.10500.) GO TO 2	K	21
	P=.00345*RHO*EXP(.854*ALOG(HUM))	K	22
	Z=1.0	K	23
	GO TO 9	K	24
2	IF (HUM.GE.35500.) GO TO 3	K	25
	RHOLOG=ALOG10(RHO)	K	26
	XD=5.*ALOG10(HUM)-20.	K	27
	PLOG=.955+RHOLOG+(.1545+.0131*RHOLOG)*XD+.016*RHOLOG*XD*(2.75-XD)	K	28
	P=EXP(2.302585*PLOG)	K	29
	GO TO 5	K	30
3	DV=1.565+1.036*ALOG10(RHO)	K	31
	IF (HUM.GE.178000.) GO TO 4	K	32
	XD=5.*ALOG10(HUM)-24.	K	33
	PLOG=.1336*XD+.00934*XD**3+DV	K	34
	P=EXP(2.302585*PLOG)	K	35
	GO TO 5	K	36
4	IF (HUM.GE.600000.) WRITE (6,17)	K	37
	PLOG=.95*ALOG10(HUM)-4.58+DV	K	38
	P=EXP(2.302585*PLOG)	K	39
	GO TO 5	K	40
C	COMPUTE Z(H,RHO)	K	41
5	XI=1.0-ALOG10(RHO)	K	42

	XD=ALOG10(HUM)-4.+0.052*XI-.004*XI**2	K	43
	IF (XD.GT.0.) GO TO 6	K	44
	Z=1.0	K	45
	GO TO 9	K	46
6	IF (XD.GT.0.55) GO TO 7	K	47
	Z=1.0+.53*XD**2	K	48
	GO TO 9	K	49
7	IF (XD.GE.1.3) GO TO 8	K	50
	XI=1.3-XD	K	51
	Z=2.0+XI*(-1.78+XI*(.21+XI*(1.09-.446*XI*XI)))	K	52
	GO TO 9	K	53
8	IF (XD.GE.2.) WRITE (6,17)	K	54
	XI=1.9-XD	K	55
	Z=3.831+XI*(-5.019+XI*(3.41+.24*XI))	K	56
9	T=(273.*P)/(Z*RHO)	K	57
	ZDUM=Z	K	58
	TDUM=T	K	59
	PDUM=1.01325E6*P/(RHOIN*UINS)	K	60
	GO TO 14	K	61
10	WRITE (6,16)	K	62
	GO TO 12	K	63
11	WRITE (6,18)	K	64
12	KEZ=1	K	65
	GO TO 14	K	66
13	WRITE (6,19)	K	67
	GO TO 15	K	68
14	RETURN	K	69
15	STOP	K	70
C		K	71
C		K	72
16	FORMAT (10X22HH IS ZERO OR NEGATIVE)	K	73
17	FORMAT (10X25HH IS LARGER THAN ALLOWED)	K	74
18	FORMAT (10X28HRHO IS SMALLER THAN ALLOWED)	K	75
19	FORMAT (10X27HRHO IS LARGER THAN ALLOWED)	K	76
	END	K	77-

THER

Subprogram THER is called by RANH to calculate the partial derivatives of equilibrium-air properties which are used in computing the derivatives at the shock wave. THER has a calling sequence in which R, EMUREF, and the free-stream conditions PIN, RHOIN, and UINS are constants. PDUM (P1), RHODUM (RHO1), and STAENT are computed in RANH. The quantities C1P ($\partial p / \partial h$) and C2P ($\partial p / \partial p$) are calculated in THER. The flow chart for subprogram THER is as follows:



	SUBROUTINE THER (R,PDUM,RHODUM,TDUM,ZDUM,STAENT,EMUREF,PIN,RHOIN,U	I	1
	1INS,C1P,C2P,C1D,C2D)	I	2
C		I	3
C	THIS IS THE NEW THERMOCHEMICAL ROUTINE THER 4-19-67	I	4
C		I	5
C		I	6
	Z=ZDUM	I	7
	P=PDUM	I	8
	HUM=EMUREF*UINS*STAENT/R	I	9
	RHO=RHOIN/1.29313E-3*RHODUM	I	10
	RUN=1.	I	11
	XC1PDP=5.*ALOG10(HUM)-20.	I	12
	IF (RHO.LE..00003) GO TO 8	I	13
	IF (RHO.GE.30.) GO TO 9	I	14
	IF (HUM.LE.0.) GO TO 6	I	15
	IF (HUM.GT.5800.) GO TO 1	I	16
	C1P=.975134E-3/RUN*RHO	I	17
	C2P=.975134E-3*HUM	I	18
	GO TO 5	I	19
1	IF (HUM.GT.10500.) GO TO 2	I	20
	C1P=.345E-2*.854*RHO/(RUN*HUM**.146)	I	21
	C2P=.345E-2*HUM	I	22
	GO TO 5	I	23
2	IF (HUM.GE.35500.) GO TO 3	I	24
	C1P=5.*P/(HUM*RUN)*(.1545+(.0131+.016*(2.75-2.*XC1PDP))*ALOG10(RHO	I	25
	1))	I	26
	C2P=P/RHO*(1.+XC1PDP*(.0131+.016*(2.75-XC1PDP)))	I	27
	GO TO 5	I	28
3	DV=1.565+1.036*ALOG10(RHO)	I	29
	IF (HUM.GE.178000.) GO TO 4	I	30
	C2P=1.036*P/RHO	I	31
	C1P=5.*P/(HUM*RUN)*(.1336+.02802*(5.*ALOG10(HUM)-24.))**2)	I	32
	GO TO 5	I	33
4	IF (HUM.GE.600000.) GO TO 7	I	34
	C1P=.95*P/(HUM*RUN)	I	35
	C2P=1.036*P/RHO	I	36
5	T=(273.*P)/(Z*RHO)	I	37
	TDUM=T	I	38
	C1D=C1P*1.01325E6/(RHOIN*R)*EMUREF	I	39
	C2D=C2P*1.01325E6/(1.29313E-3*UINS)	I	40
	GO TO 11	I	41
6	WRITE (6,12)	I	42

	GO TO 10	I	43
7	WRITE (6,13)	I	44
	GO TO 10	I	45
8	WRITE (6,14)	I	46
	GO TO 10	I	47
9	WRITE (6,15)	I	48
	GO TO 10	I	49
10	CONTINUE	I	50
11	RETURN	I	51
C		I	52
C		I	53
12	FORMAT (10X22HH IS ZERO OR NEGATIVE)	I	54
13	FORMAT (10X25HH IS LARGER THAN ALLOWED)	I	55
14	FORMAT (10X28HRHO IS SMALLER THAN ALLOWED)	I	56
15	FORMAT (10X27HRHO IS LARGER THAN ALLOWED)	I	57
	END	I	58-

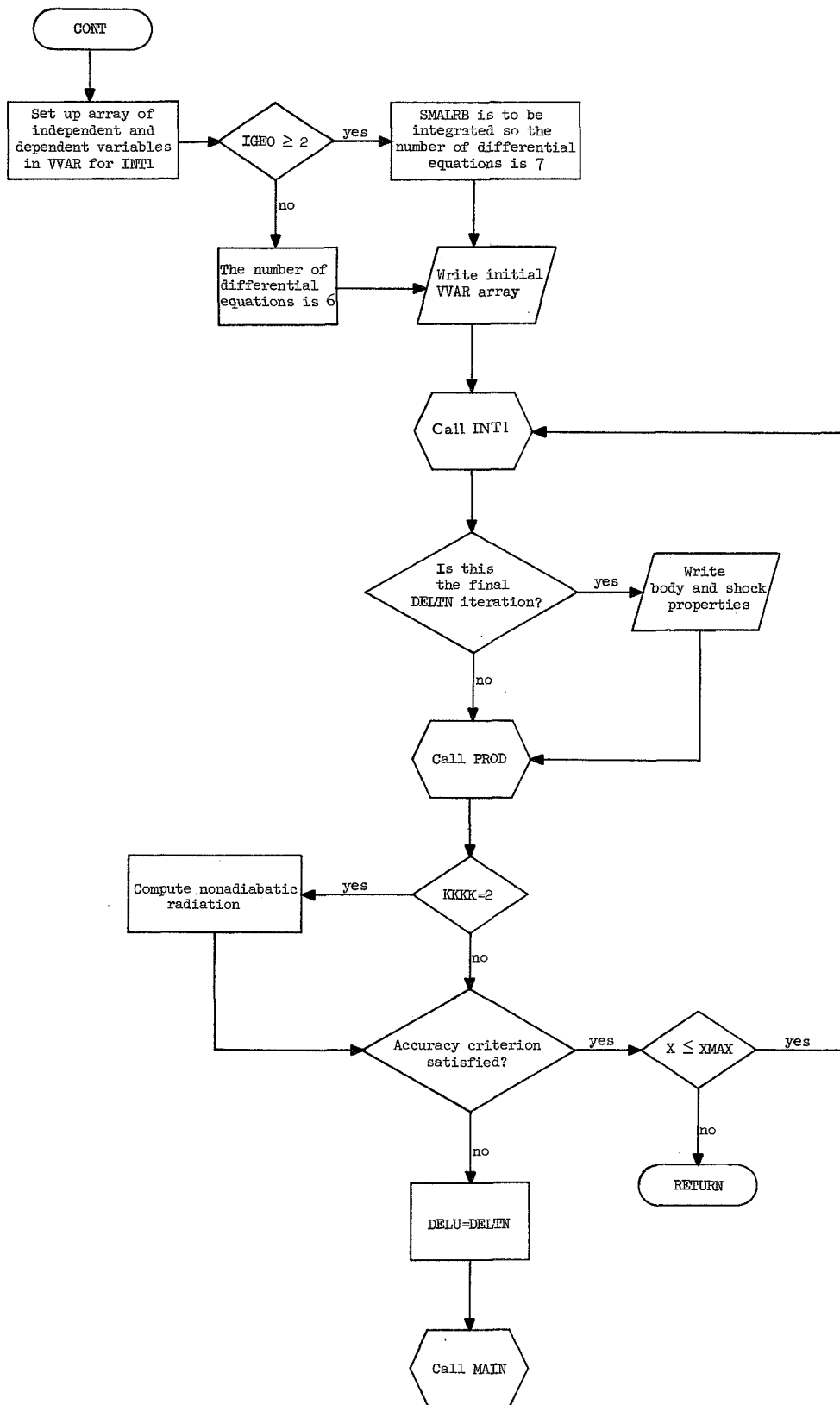
CONT

In subprogram CONT the array of variables for INT1, the integration routine, is established and INT1 is called to evaluate the derivatives. CONT writes the output from the integration routine. PROD is called to compute the η distribution and if KKKK is greater than zero, to compute the radiation. To minimize the use of the time-consuming radiation subroutine RADFLUX, curve fits to the radiation distribution around the body are used for all except the last iteration. The curve-fit expressions are

$$QRY1 = (1 + QI1 \times X^2 + QI2 \times X^4)QRY1_{stag}$$

$$QRYO = (1 + QO1 \times X^2 + QO2 \times X^4)QRYO_{stag}$$

where QI1, QI2, QO1, and QO2 are coefficients which describe the curve fit. The curve-fit coefficients are input values and are based on available data for radiation distributions or on the experience of the user. If no basis exists for these coefficients, the radiation heat fluxes should be computed at each integration step. The flow chart for subprogram CONT is as follows:

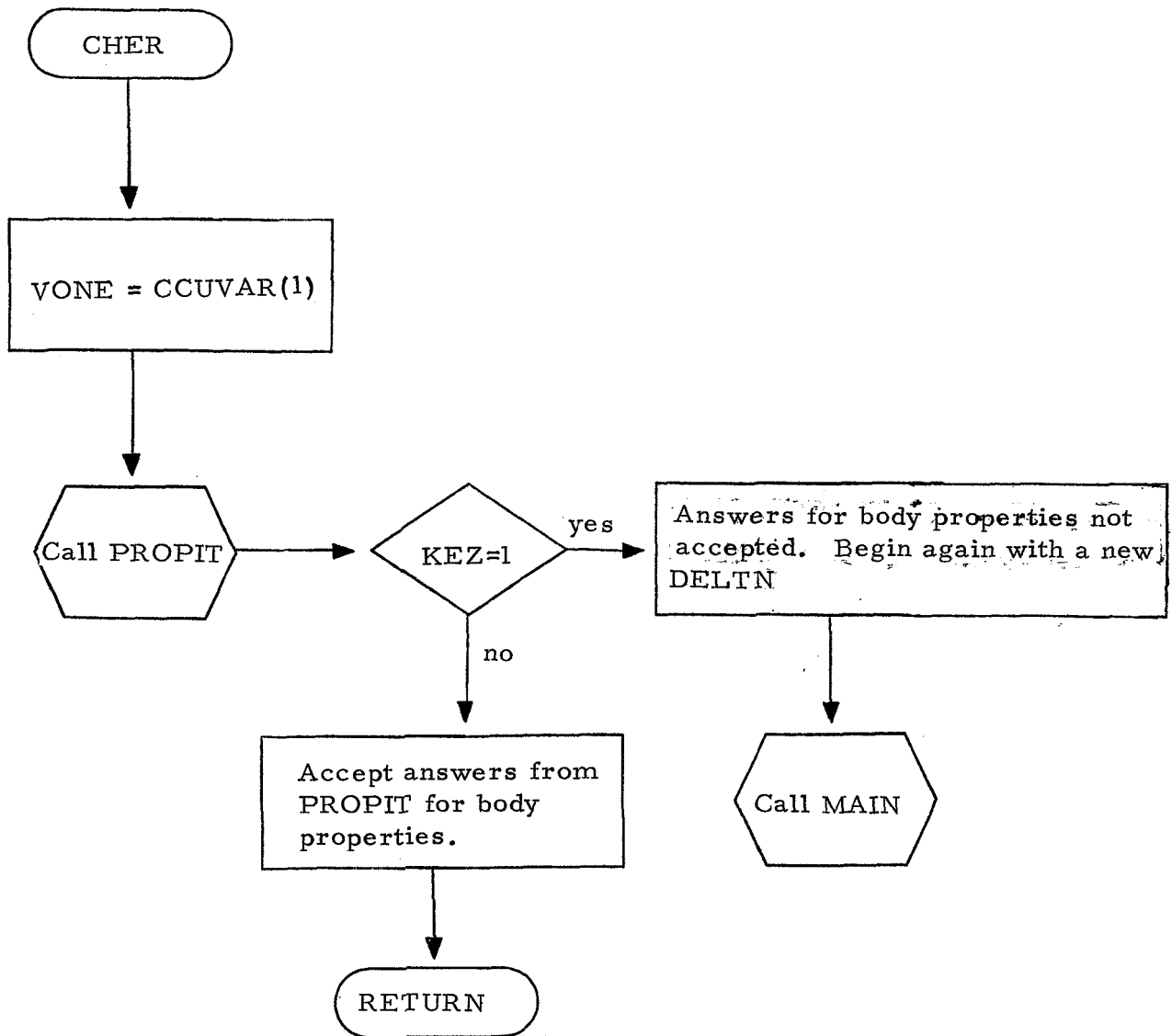


	SUBROUTINE CONT	G	1
	DOUBLE PRECISION VVAR,CCUVAR	G	2
C		G	3
C		G	4
	COMMON /MAINP/ AA1(6),AC,AO,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	G	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	G	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	G	7
	301DW,DTBDX,DUSDW,DUIDW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	G	8
	4EE1(6),ERRVAL(7),EMUREF,E01,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	G	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,K<KK,OPERA,P,PEEP,PIN,PO,PSTAG,	G	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	G	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIN,UINS,UO,US,U1,	G	12
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	G	13
	COMMON /QQQ/ QI1,QI2,Q01,Q02,QRY1,QRY0,QSTAG	G	14
	EXTERNAL DERSUB	G	15
	EXTERNAL CHSUB	G	16
	PCOREL=1.	G	17
	IT=0	G	18
	VVAR(1)=X	G	19
	VVAR(2)=DELTA	G	20
	VVAR(3)=W	G	21
	DIODX(4)=0	G	22
	DO 1 KM=2,5	G	23
	VVAR(KM+2)=XIO(KM)	G	24
1	CONTINUE	G	25
C	IF IGEO IS EQUAL TO 2 DRBDX IS INTEGRATED	G	26
C	NE IS THE NUMBER OF EQUATIONS TO BE INTEGRATED	G	27
C		G	28
	IF (IGEO-2) 2,3,3	G	29
2	NE=6	G	30
	GO TO 4	G	31
3	NE=7	G	32
	VVAR(8)=SMALRB	G	33
4	IF (KEKONT.LT.KETEST) GO TO 5	G	34
	WRITE (6,11) (VVAR(J),J=1,8)	G	35
5	CALL INT1 (IT,NE,3,CCI,SSPEC,CIMAX,IERR,VVAR,CCUVAR,DDER,EELE1,EEL	G	36
	1E2,EELT,ERRVAL,DERSUB,CHSUB,ITEXT)	G	37
	COSTB=COS(THETAB)	G	38
	SINTB=SIN(THETAB)	G	39
	SMALLRS=(1.+DELTA)*COSTB	G	40
	ZS=1.-(1.+DELTA)*SINTB	G	41
	DELTD=DELTA*RB	G	42

	IPROD=2	G	43
	USTAR=2.	G	44
C		G	45
C	IF KKKK=0 THE RADIATION IS NOT COMPUTED, KKKK=1 ADIABATIC	G	46
C	RADIATION IS COMPUTED, KKKK=2 FOR NONADIABATIC RADIATION	G	47
C		G	48
	IF (KEKONT.LT.KETEST) GO TO 6	G	49
	WRITE (6,12) (CCUVAR(JK),JK=1,8),(XI1(JJ),JJ=2,5),RBX,THETAB,CAPQ,	G	50
	1(DDER(IL),IL=2,8)	G	51
	CALL PROD (USTAR,IPROD,UO,U1,QRYO,QR1)	G	52
	IF (KKKK.NE.2) GO TO 7	G	53
	R1=(1.+QD)*(1.+DAF)*QR1-QRYO	G	54
	QR1OP=1.E-7*QRYO*RHOIN*UINS*UIN	G	55
	QRATIO=QR1OP/QSTAG	G	56
	GO TO 7	G	57
	XS=X**2	G	58
	QSTAR1=(1.+QI1*XS+QI2*XS**2)*QR1	G	59
	QSTARO=(1.+QO1*XS+QO2*XS**2)*QR1	G	60
	IF (KKKK.NE.2) GO TO 7	G	61
	R1=(1.+QD)*(1.+DAF)*QSTAR1-QSTARO	G	62
7	PRATIO=PO/PSTAG	G	63
	PDIF=PCOREL-PRATIO	G	64
	IF (KEKONT.EQ.KETEST) WRITE (6,13) PRATIO,QRATIO	G	65
	IF (PDIF) 8,9,9	G	66
8	DELU=DELTN	G	67
	CALL MAIN	G	68
9	PCOREL=PRATIO	G	69
	IF (X-XMAX) 5,5,10	G	70
10	RETURN	G	71
C		G	72
C		G	73
11	FORMAT (1H011X44H PROPERTIES AT FIRST STEP OFF STAGNATION LINE/8X1H	G	74
	1XD15.8,5X5HDELTAD15.8,9X1HWD15.8,5X5HIO(2)D15.8,5X5HIO(3)D15.8/5X5	G	75
	2HIO(4)D15.8,5X5HIO(5)D15.8,4X6HSMALRBD15.8/)	G	76
12	FORMAT (1H1/10X25H BODY AND SHOCK PROPERTIES/9X1HXD15.8,5X5HDELTAD1	G	77
	15.8,9X1HWD15.8,5X5HIO(2)D15.8,5X5HIO(3)D15.8/5X5HIO(4)D15.8,5X5HIO	G	78
	2(5)D15.8,4X6HSMALRBD15.8,5X5HI1(2)E15.8,5X5HI1(3)E15.8/5X5HI1(4)E1	G	79
	35.8,5X5HI1(5)E15.8,7X3HRBXE15.8,4X6H THETABE15.8,9X1HQE15.8/4X6H DDE	G	80
	4LDXE15.8,6X4HWDXE15.8,2X8HDIODX(2)E15.8,2X8HDIODX(3)E15.8,2X8HDI O	G	81
	5DX(4)E15.8/2X8HDIODX(5)E15.8,1X9HDSMALRBDXE15.8/)	G	82
13	FORMAT (1H06X6H PRATIOE15.8,2X6H QRATIOE15.8/)	G	83
	END	G	84-

CHER

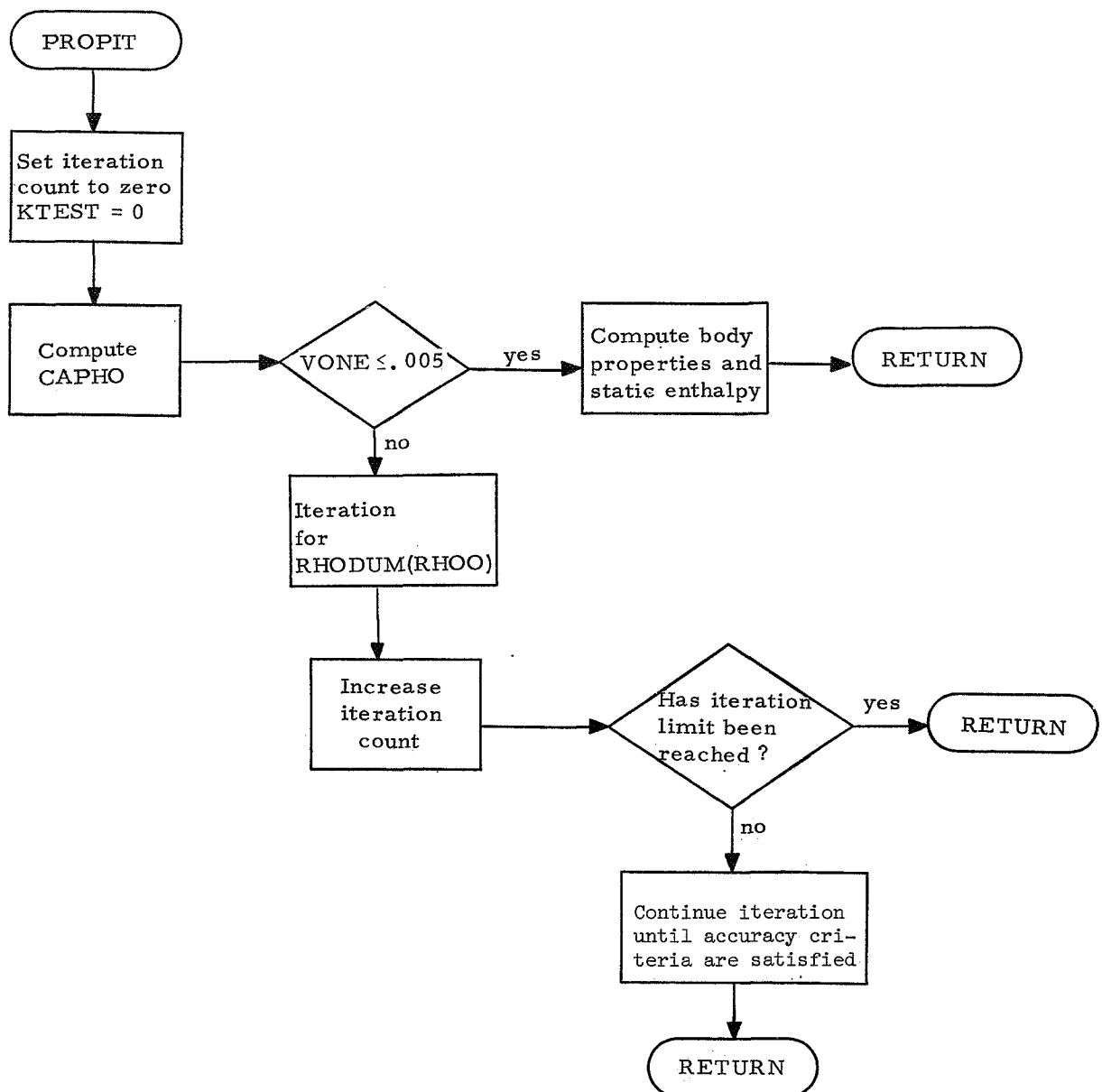
An additional test on the DELTN (δ_0) iteration is performed in CHER. After PROPIT returns to CHER, KEZ is tested. If the RHO computed in THEP is too small, KEZ is set to 1. When this is the case, DELL = DELTN and CHER then calls MAIN to reinitialize the program with a new DELTN. CHER is called by DERSUB. The flow chart for subprogram CHER is as follows:



	SUBROUTINE CHER	N	1
	DOUBLE PRECISION VVAR,CCUVAR	N	2
C		N	3
C		N	4
	COMMON /MAINP/ AA1(6),AC,AD,AQVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	N	5
	IC1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	N	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	N	7
	3O1DW,DTBDX,DUSDW,DUIDW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	N	8
	4EE1(6),ERRVAL(7),EMUREF,E01,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	N	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	N	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	N	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	N	12
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	N	13
		N	14
	VONE=CCUVAR(1)	N	15
	CALL PROPIT (R,UINS,XIO,TO,PO,RHOO,ITTEST,RHOIN,STAENT,ZDUM,KEZ,EP	N	16
	1S21,AD,VONE,CAPHO,UO,PIN,EMUREF)	N	17
	IF (KEZ.EQ.1) GO TO 1	N	18
	RETURN	N	19
1	DELL=DELTN	N	20
	CALL MAIN	N	21
	END	N	22-

PROPIT

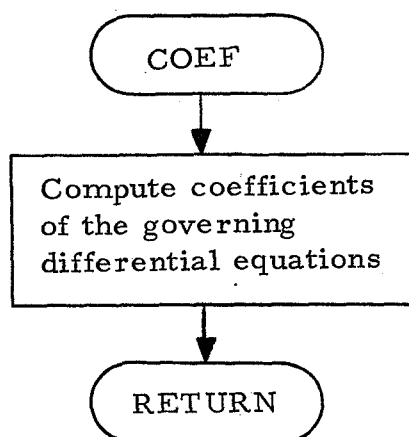
PROPIT is a subprogram called by CHER during each integration step to solve for the body properties through a Newton-Raphson iteration scheme. PROPIT has a calling sequence in which R, UINS, RHOIN, PIN, ITTEST, EPS21, and EMUREF are constants. The variables XIO, AO, and CAPHO are computed for the particular value of VONE, the independent variable X, when PROPIT is called. The body properties, PDUM, RHODUM, UGEN, TGEN, and ZDUM and the static enthalpy STAENT are computed by the subprogram. An indicator KEZ is set in THEP when RHO is too small. The flow chart for subprogram PROPIT is as follows:



	SUBROUTINE PROPIT (R,UINS,XIO,TGEN,PDUM,RHODUM,ITTEST,RHOIN,STAENT	M	1
	1,ZDUM,KEZ,EPS21,AQ,VONE,CAPHO,UGEN,PIN,EMUREF)	M	2
C		M	3
	DIMENSION XIO(6)		
C	KTEST IS THE NUMBER OF ITERATIONS ALLOWED ON RHO	M	5
	KTEST=0	M	6
	KEZ=0	M	7
	CAPHO=XIO(5)/XIO(2)	M	8
	XIO2S=XIO(2)**2	M	9
	IF (VONE-.005) 1,1,3	M	10
1	UGEN=AQ*VONE	M	11
	UGENS=UGEN**2	M	12
	STAENT=CAPHO-UGENS/2.	M	13
	RHODUM=XIO(2)/UGEN	M	14
	RUGS=RHODUM*UGENS	M	15
	PDUM=XIO(3)-RUGS	M	16
C		M	17
C		M	18
2	RETURN	M	19
3	STAENT=CAPHO-.5*XIO2S/(RHODUM**2)	M	20
	CALL THEP (R,PDUM,RHODUM,TGEN,ZDUM,STAENT,EMUREF,PIN,RHOIN,UINS,KE	M	21
	1Z)	M	22
	IF (KEZ.EQ.1) RETURN	M	23
	FRODUM=RHODUM-(XIO(3)-PDUM)*(RHODUM**2)/XIO2S	M	24
	DELRHO=-.1	M	25
	RHODMP=RHODUM+DELRHO	M	26
	STAD=CAPHO-.5*XIO2S/(RHODMP**2)	M	27
	CALL THEP (R,PD,RHODMP,TD,ZD,STAD,EMUREF,PIN,RHOIN,UINS,KEZ)	M	28
	FPRHO=(RHODMP-(XIO(3)-PD)*(RHODMP**2)/XIO2S-FRODUM)/DELRHO	M	29
	FROFPR=FRODUM/FPRHO	M	30
	AFRFPR=ABS(FROFPR)	M	31
	IF (AFRFPR-EPS21) 6,6,4	M	32
4	KTEST=KTEST+1	M	33
	IF (KTEST-ITTEST) 5,7,7	M	34
5	RHODUM=RHODUM-FROFPR	M	35
	GO TO 3	M	36
6	UGEN=XIO(2)/RHODUM	M	37
	UGENS=UGEN**2	M	38
	RUGS=RHODUM*UGENS	M	39
	GO TO 2	M	40
7	WRITE (6,8)	M	41
	KEZ=1	M	42
	RETURN	M	43
C		M	44
C		M	45
8	FORMAT (1H06X34HITERATION LIMIT REACHED IN PROPIT)	M	46
	END	M	47

COEF

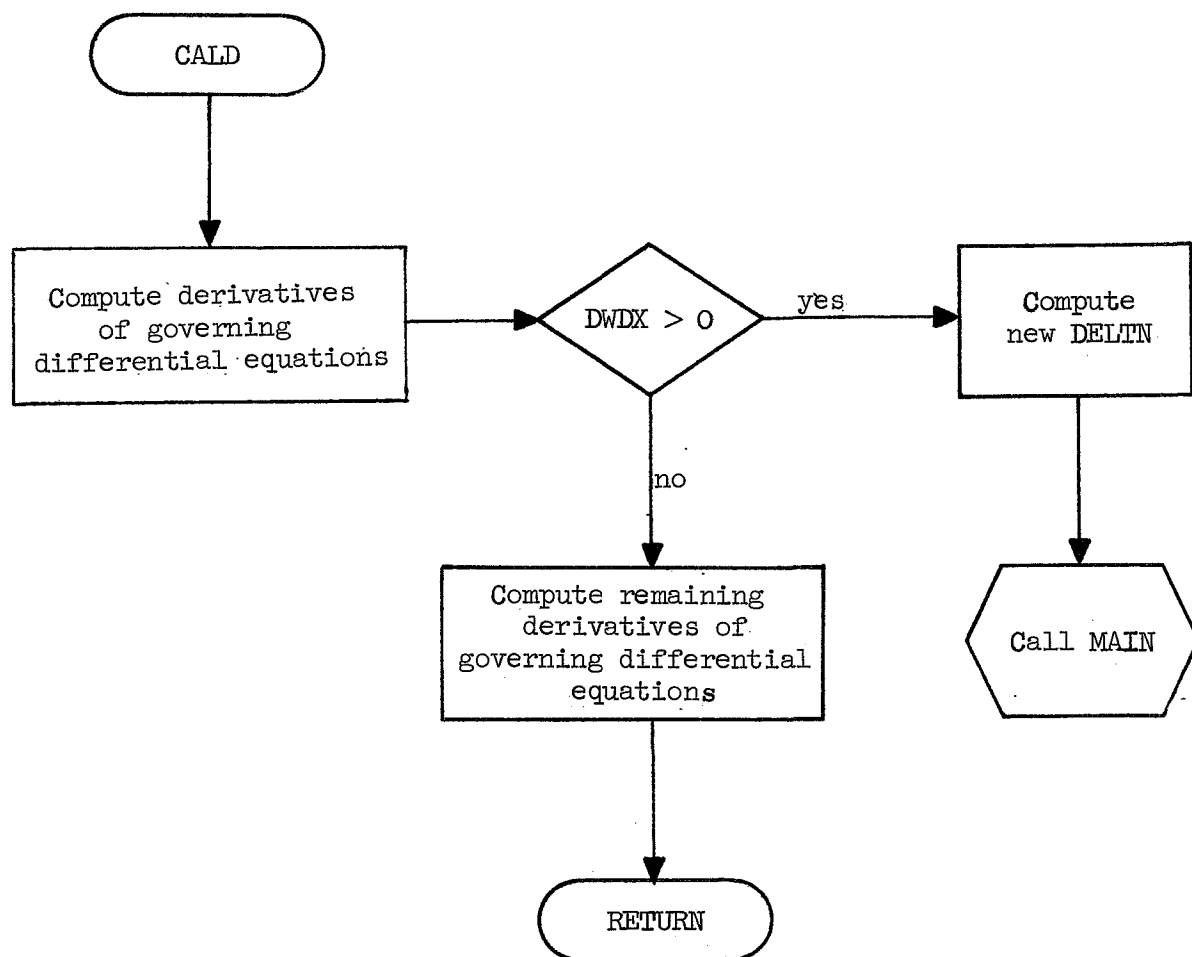
Subprogram COEF is called by DERSUB to calculate the coefficients of the governing differential equations. The flow chart for subprogram COEF is as follows:



	SUBROUTINE COEF	J	1
C		J	2
	DOUBLE PRECISION VVAR,CCUVAR	J	3
C		J	4
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	J	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	J	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DPIOW,DRBDX,DR	J	7
	301DW,DTBDX,DUSDW,DUIDW,DVSDW,DVIDW,DWDX,EELE1(7),EELE2(7),EELT(3),	J	8
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	J	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	J	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RHO1,R1,SINTB,SINSQW,SINW,SMALLB,SM	J	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	J	12
	8V,VQ,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	J	13
C		J	14
	CAPR1=R1	J	15
C		J	16
	TPTOD=3.+2.*DAF	J	17
	AA1(2)=3.*(XIO(2)-XI1(2))+2.*DAF*(XIO(2)-XI1(2))	J	18
	AA1(3)=3.*(XIO(3)-XI1(3))+2.*DAF*(XIO(3)-XI1(3))	J	19
	AA1(4)=-TPTOD*XI1(4)	J	20
	AA1(5)=3.*(XIO(5)-XI1(5))+2.*DAF*(XIO(5)-XI1(5))	J	21
	DO 1 J=2,5	J	22
	BB1(J)=DELTA*TPTOD*DI1DW(J)	J	23
1	CONTINUE	J	24
	CC1=DELTA*(3.+DAF)	J	25
	DD1=1.	J	26
	EO1=-(1.+CAPQ*DELTA)/CAPQ*SWMTB/CWMTB*DTBDX	J	27
	GG1(5)=RHO1*V1*CAPH1	J	28
	GG1(2)=RHO1*V1	J	29
	GG1(3)=RHO1*U1*V1	J	30
	GG0(4)=PO	J	31
	GG1(4)=P1+RHO1*V1**2	J	32
	EE1(2)=3.*DOSRB*(XIO(2)+XI1(2))*DRBDX-DELS*OPERA*(XIO(2)+2.*XI1(2)	J	33
	1)*DTBDX+6.*(1.+QD)*(1.+DAF)*GG1(2)+DELTA*TPTOD*GG1(2)*DTBDX	J	34
	EE1(3)=3.*DOSRB*(RHOO*UO**2+RHO1*U1**2)*DRBDX-DELS*OPERA*(RHOO*UO*	J	35
	1**2+2.*RHO1*U1**2)*DTBDX+QD*(3.+2.*DAF)*XI1(4)+6.*(1.+QD)*(1.+DAF)*	J	36
	2XI1(4)+2.*DELTA*TPTOD*XI1(4)*DTBDX	J	37
	EE1(4)=3.*DOSRB*XI1(4)*DRBDX-2.*DELS*OPERA*XI1(4)*DTBDX-3.*(QD+DAF	J	38
	1)*(XIO(3)+XI1(3))-2.*QD*DAF*(XIO(3)+2.*XI1(3))+6.*(1.+QD)*(1.+DAF)	J	39
	2*GG1(4)-6.*GG0(4)+QD*DAF*(RHOO*UO**2+2.*RHO1*U1**2)+3.*DAF*(RHOO*U	J	40
	30**2+RHO1*U1**2)+DELTA*(3.+2.*DAF)*RHO1*(V1**2-U1**2)*DTBDX	J	41
	EE1(5)=3.*DOSRB*(XIO(5)+XI1(5))*DRBDX-DELS*OPERA*(XIO(5)+2.*XI1(5)	J	42
	1)*DTBDX+6.*(1.+QD)*(1.+DAF)*GG1(5)+6.*R1+DELTA*(3.+2.*DAF)*GG1(5)*	J	43
	2DTBDX	J	44
	RETURN	J	45
	END	J	46-

CALD

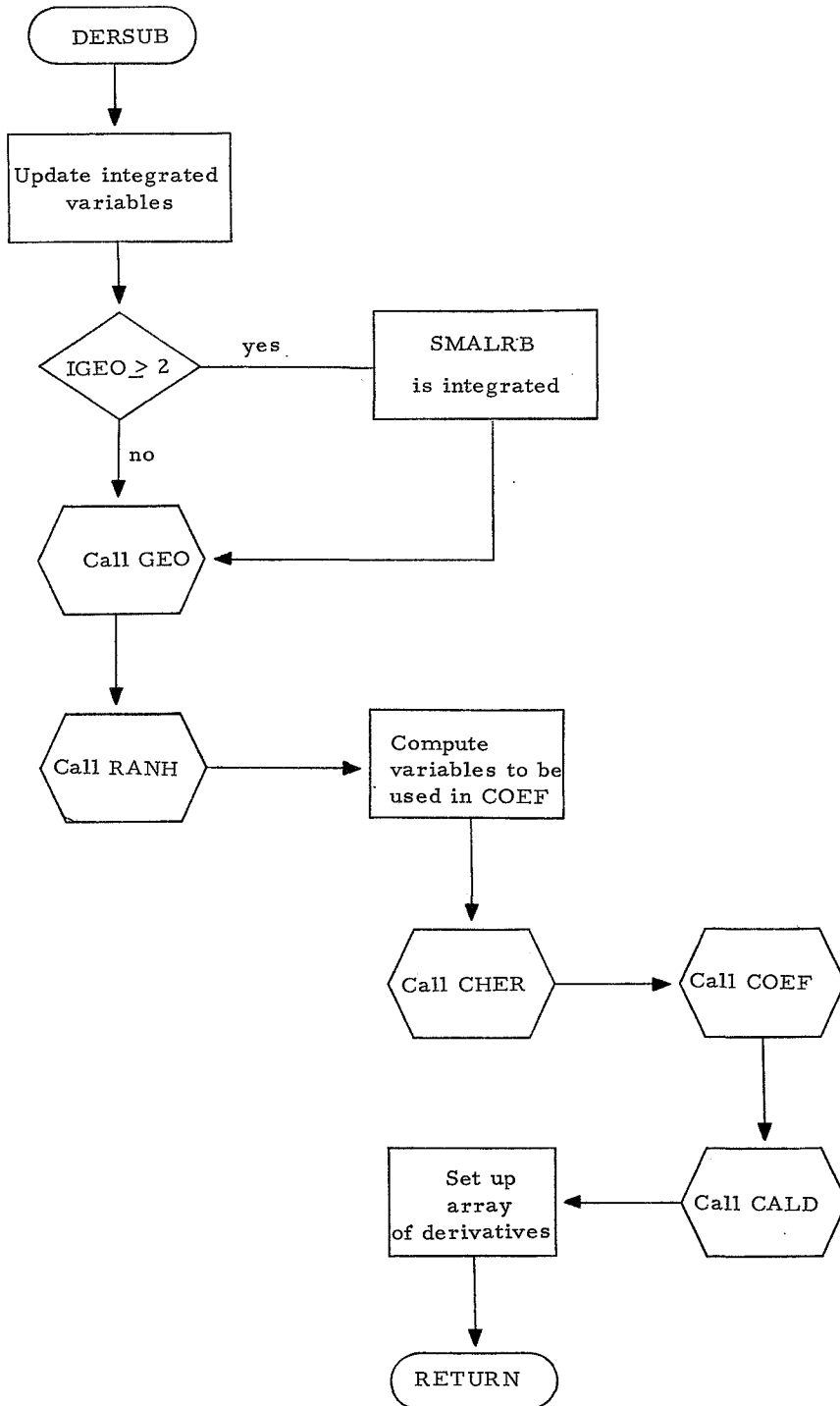
The derivatives of the governing differential equations which are used in DERSUB are computed in CALD. CALD is called by DERSUB. The flow chart for subprogram CALD is as follows:



SUBROUTINE CALD	D	1
DOUBLE PRECISION VVAR,CCUVAR	D	2
	D	3
	D	4
COMMON /MAINP/ AA1(6),AC,AO,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	D	5
1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,ODER(8),DD1	D	6
2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	D	7
301DW,DTBDX,DUSOW,DUI1DW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	D	8
4EE1(6),ERRVAL(7),EMUREF,E01,EPSR,EPS21,GG0(6),GG1(5),HONE,ICDSW,IE	D	9
5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	D	10
6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	D	11
7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	D	12
8V,VQ,VS,V1,VVAR(8),W,X,XI0(6),XI1(6),XMAX,ZO,Z1	D	13
	D	14
RBS=SMALRB**2	D	15
RACE=RBS/(SMALLB**2-RBS)	D	16
IF (IGEO-2) 3,1,2	D	17
DRBDX=1./SQRT(1.+AOVERB**2*RACE)	D	18
GO TO 3	D	19
DRBDX=1./(1.+AOVERB**2*SMALRB/(SMALLB**2+RBS))	D	20
DDELDX=E01	D	21
DWDX=(-AA1(4)*DDELDX-EE1(4))/BB1(4)	D	22
IF (DWDX) 5,5,4	D	23
DELU=DELTN	D	24
CALL MAIN	D	25
DIODX(2)=(-AA1(2)*DDELDX-BB1(2)*DWDX-EE1(2))/CC1	D	26
DIODX(3)=UO*DIODX(2)	D	27
DIODX(5)=(-AA1(5)*DDELDX-BB1(5)*DWDX-EE1(5))/CC1	D	28
RETURN	D	29
END	D	30-

DERSUB

DERSUB is a subprogram used by INT1, the integration routine, to evaluate the derivatives. The flow chart for subprogram DERSUB is as follows:



	SUBROUTINE DERSUB	H	1
	DOUBLE PRECISION VVAR,CCUVAR	H	2
C		H	3
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPHD,CAPH1,CAPQ,CC,C	H	4
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	H	5
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,OP1DW,DRBDX,DR	H	6
	3O1DW,DTBDX,DUSDW,DULDW,DVSDW,DVIDW,DWDX,EELE1(7),EELE2(7),EELT(3),	H	7
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	H	8
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	H	9
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RHO1,R1,SINTB,SINSQW,SINW,SMALLB,SM	H	10
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	H	11
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	H	12
C		H	13
	X=CCUVAR(1)	H	14
	DELTA=CCUVAR(2)	H	15
	W=CCUVAR(3)	H	16
	DO 1 I=2,5	H	17
	XIO(I)=CCUVAR(I+2)	H	18
1	CONTINUE	H	19
	IF (IGEO.GE.2) SMALRB=CCUVAR(8)	H	20
	CALL GEO	H	21
	CALL RANH	H	22
	DOSRB=DELTA/SMALRB	H	23
	COSTB=COS(THETAB)	H	24
	SINTB=SIN(THETAB)	H	25
	DAF=DELTA*COSTB/SMALRB	H	26
	OPERA=SINTB/SMALRB	H	27
	CALL CHER	H	28
	CALL COEF	H	29
	CALL CALD	H	30
	DDER(2)=DDELDX	H	31
	DDER(3)=DWDX	H	32
	DO 2 I=2,5	H	33
	DDER(I+2)=DIODX(I)	H	34
2	CONTINUE	H	35
	IF (IGEO.GE.2) DDER(8)=DRBDX	H	36
	RETURN	H	37
	END	H	38-

CHSUB

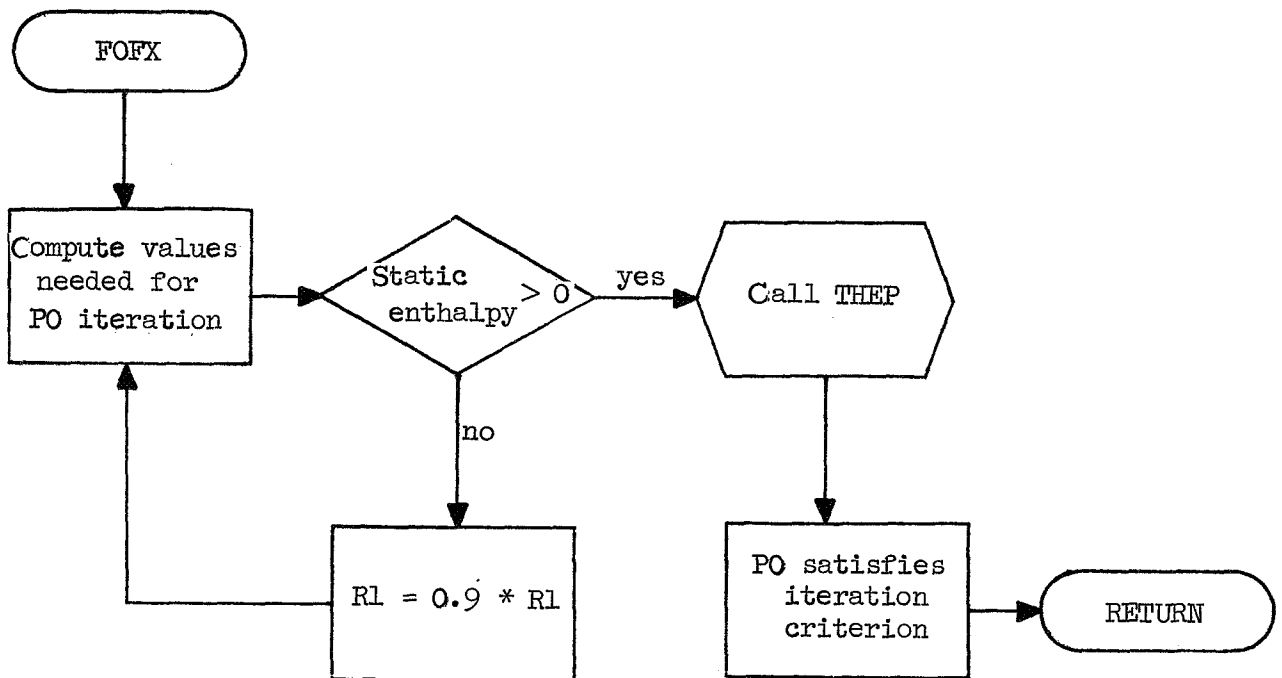
CHSUB is called by INT1. It is written by the user and is described in appendix A. In program D1250 the features of CHSUB are not needed; therefore, CHSUB is a dummy routine.

```
SUBROUTINE CHSUB  
RETURN  
END
```

```
E 1  
E 2  
E 3-
```

FOFX

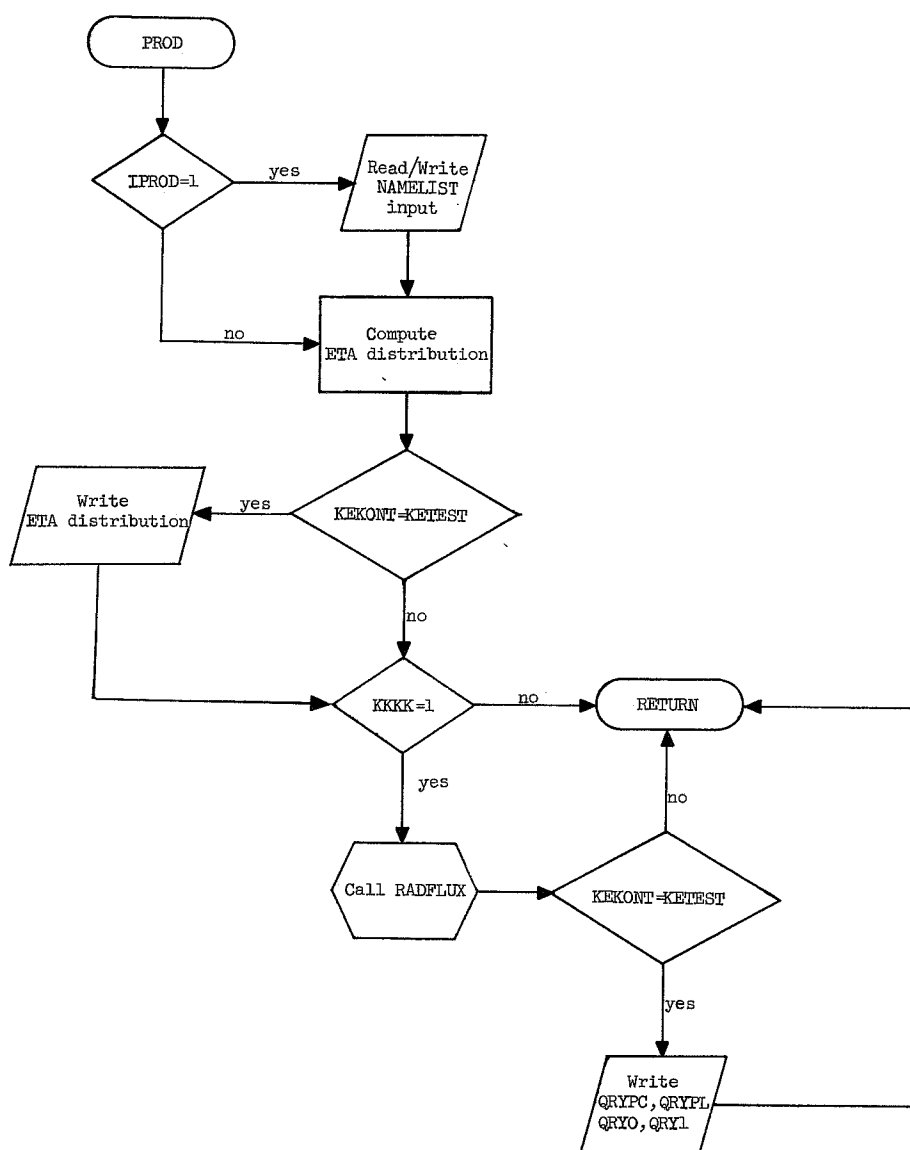
FOFX is a function subprogram called by ITR1 to evaluate p_0 (in FOFX, $p_0 = p_{\text{stag}}$). The flow chart for subprogram FOFX is as follows:



	FUNCTION FOFX (PDUM)	0	1
C		0	2
C		0	3
	DOUBLE PRECISION VVAR,CCUVAR	0	4
	COMMON /MAINP/ AA1(6),AC,AO,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	0	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	0	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIOOX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	0	7
	3O1DW,DTBDX,DUSDW,DUIDW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	0	8
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	0	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	0	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	0	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	0	12
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XII(6),XMAX,ZO,Z1	0	13
	ROPE=-(AC**2*(P1-PDUM)**2)/(PEEP*CC**2*PDUM)	0	14
1	STAPE=CAPH1-3.*R1/(AC*(P1-PDUM))	0	15
	IF (STAPE.GT.0) GO TO 2	0	16
	R1=.9*R1	0	17
	GO TO 1	0	18
2	CALL THEP (R,POX,ROPE,TD,ZD,STAPE,EMUREF,PIN,RHOIN,UINS,KEZ)	0	19
	FOFX=POX	0	20
	RETURN	0	21
	END	0	22-

PROD

Subprogram PROD reads and writes the radiation NAMELIST input RAD1 and calls the subprogram to compute radiation. The thermodynamic properties within the shock layer are computed in the η distribution. PROD has a calling sequence in which USTAR determines whether the properties are off the stagnation point. If they are off the stagnation point, USTAR becomes the velocity at the body surface. IPROD is the option to read the radiation input data. AUODUM and AU1DUM represent a_0 and a_1 when PROD is called by MAIN and u_0 and u_1 when PROD is called by CONT. QRYO and QRY1 are computed by RADFLUX and are the total radiation heat fluxes at the body and shock, respectively. The flow chart for subprogram PROD is as follows:



	SUBROUTINE PROD (USTAR,IPROD,AUODUM,AU1DUM,QRYO,QRY1)	P	1
C		P	2
	DOUBLE PRECISION VVAR,CCUVAR	P	3
C		P	4
	COMMON /MAINP/ AA1(6),AC,AO,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	P	5
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	P	6
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	P	7
	3Q1DW,DTBOX,DUSDW,DU1DW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	P	8
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	P	9
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	P	10
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOD,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	P	11
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	P	12
	8V,VO,VS,V1,VVAR(8),W,X,XID(6),XI1(6),XMAX,ZO,Z1	P	13
	COMMON /WON/ QRYPC(20),QRYPL(20)	P	14
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	P	15
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	P	16
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	P	17
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	P	18
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	P	19
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	P	20
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	P	21
	COMMON /RAD/ XNN(7,100)	P	22
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	P	23
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	P	24
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	P	25
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	P	26
	1HVM(20),FHVP(20)	P	27
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	P	28
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	P	29
	DIMENSION NICN(100)	P	30
	DIMENSION HH(100), PRES(100)	P	31
	REAL KN,KNY	P	32
	NAMelist /RAD1/ GEE,EPS,FHVM,FHVP,FHV,WOL,NU,ND,HVL,FF,GAMP,IS,NIH	P	33
	1VC,FHVC,AHV,AHVL,FL1,FL2,FLG,FLG1,NIC,NICN,IOPT,TB ,NY	P	34
C		P	35
C	THIS ROUTINE IS CALLED IN THE MAIN PROGRAM WHEN IPROD=1 TO	P	36
C	READ IN THE DATA FOR RADFLUX,WHEN IPROD =2 ,NAMelist IS NOT CALLED	P	37
C		P	38
	IF (IPROD-1) 2,1,2	P	39
1	READ (5,RAD1)	P	40
	WRITE (6,RAD1)	P	41
	WRITE (6,8)	P	42

2	UINS=UIN**2	P	43
	IQ=NY	P	44
	YY(1)=0	P	45
	IF (USTAR) 3,3,4	P	46
3	HH(1)=CAPHO*UINS/4.19E7	P	47
	GO TO 5	P	48
4	HH(1)=(CAPHO-UO**2/2.)*UINS/4.19E7	P	49
5	PRES(1)=PO*RHOIN*UINS/1.01325E6	P	50
	IF (KEKONT.EQ.KETEST) WRITE (6,9)	P	51
	ETA=0	P	52
	STAENT=CAPHO-UO**2/2.	P	53
	IF (KEKONT.EQ.KETEST) WRITE (6,10) ETA,PO,STAENT,CAPHO,AUDUM,VO	P	54
	DO 6 N=2,NY	P	55
	KN=N	P	56
	KNY=NY	P	57
	ETA=(KN-1.)/(KNY-1.)	P	58
	YY(N)=ETA	P	59
	RHOAU=RHO0*AUDUM+(RHO1*AUDUM-RHO0*AUDUM)*ETA	P	60
	RHOAUS=RHO0*AUDUM**2+(RHO1*AUDUM**2-RHO0*AUDUM**2)*ETA	P	61
	RHOAUH=RHO0*AUDUM*CAPHO+(RHO1*AUDUM*CAPH1-RHO0*AUDUM*CAPHO)*ETA	P	62
	RHOAUV=RHO1*AUDUM*V1*ETA	P	63
	AUDUM=RHOAUS/RHOAU	P	64
	V=RHOAUV/RHOAU	P	65
	IF (USTAR.GT.0) USTAR=AUDUM	P	66
	SUMH=RHOAUH/RHOAU-USTAR**2/2.-V**2/2.	P	67
	STAENT=SUMH	P	68
	CAPH=RHOAUH/RHOAU	P	69
	PDUM=PO+(QD*RHO0*UO**2)*ETA+(P1-PO-QD*RHO0*UO**2)*ETA**2	P	70
	IF (KEKONT.EQ.KETEST) WRITE (6,10) ETA,PDUM,STAENT,CAPH,AUDUM,V	P	71
	HH(N)=SUMH*UINS/4.19E7	P	72
	PRES(N)=PDUM*RHOIN*UINS/1.01325E6	P	73
6	CONTINUE	P	74
	IF (KKKK.EQ.0) GO TO 7	P	75
	CALL RADFLUX (NIC,NICN,IOPT,PRES,HH,QRYO,QRyl)	P	76
	IF (KEKONT.EQ.KETEST) WRITE (6,11) QRYPC(1),QRYPC(NY),QRYPL(1),QRY	P	77
	1PL(NY),QRYO,QRyl	P	78
7	RETURN	P	79
C		P	80
C		P	81
8	FORMAT (1H1)	P	82
9	FORMAT (1H04X31HDISTRIBUTION ACROSS SHOCK LAYER/12X3HETA14X4HPDUM1	P	83
	13X6HSTAENT11X4HCAPH13X5HAUDUM12X1HV/)	P	84
10	FORMAT (6(2XE15.8))	P	85
11	FORMAT (1H0,6X,5HQRYPC2E15.8,2X,5HQRYPL2E15.8,2X,4HQRYOE15.8,2X,4H	P	86
	1QRY1E15.8)	P	87
	END	P	88-

RADIATION SUBPROGRAMS

The radiation package was adapted from program RATRAP (ref. 4). Reference 3 describes RATRAP as it is applied to D1250. If the input quantity KKKK is greater than zero, a radiation solution is computed. Subprogram PROD links D1250 to RATRAP by reading the input for the radiation program and by calling RADFLUX. RADFLUX serves as the main program for the radiation subprograms. A listing of the radiation subprograms follows.

	SUBROUTINE RADFLUX (NIC,NICN,IOPT,PRES,HH,QRYS,QRYS1)	Q	2
C	DOUBLE PRECISION VVAR,CCUVAR	Q	3
C		Q	4
C		Q	5
	COMMON /MAINP/ AA1(6),AC,AD,AOVERB,A1,BB1(6),CAPHO,CAPH1,CAPQ,CC,C	Q	6
	1C1,CCI,CCUVAR(8),CII,CIMAX,COSTB,COSW,CWMTB,DAF,DDELDX,DDER(8),DD1	Q	7
	2,DELL,DELS,DELTA,DELTN,DELU,DIODX(6),DI1DW(6),DOSRB,DP1DW,DRBDX,DR	Q	8
	301DW,DTBDX,DUSDW,DUIDW,DVSDW,DV1DW,DWDX,EELE1(7),EELE2(7),EELT(3),	Q	9
	4EE1(6),ERRVAL(7),EMUREF,ED1,EPSR,EPS21,GG0(6),GG1(6),HONE,ICOSW,IE	Q	10
	5RR,IGEO,ITEXT,ITTEST,KEKONT,KETEST,KKKK,OPERA,P,PEEP,PIN,PO,PSTAG,	Q	11
	6P1,QD,R,RB,RBX,RHOIN,RHON,RHOO,RH01,R1,SINTB,SINSQW,SINW,SMALLB,SM	Q	12
	7ALRB,STAENT,SSPEC,SWMTB,T,TCG,TEAN,THETAB,TO,T1,UIIN,UINS,UO,US,U1,	Q	13
	8V,VO,VS,V1,VVAR(8),W,X,XIO(6),XI1(6),XMAX,ZO,Z1	Q	14
	COMMON /WON/ QRYPC(20),QRYPL(20)	Q	15
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	Q	16
	1C(16,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	Q	17
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	Q	18
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(15),VNT(17),VNU(1	Q	19
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	Q	20
	5QN,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	Q	21
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	Q	22
	COMMON /RAD/ XNN(7,100)	Q	23
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	Q	24
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	Q	25
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	Q	26
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	Q	27
	1HVM(20),FHVP(20)	Q	28
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	Q	29
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	Q	30
	DIMENSION NICN(100)	Q	31
	DIMENSION PRES(100)	Q	32
	DIMENSION HH(100)	Q	33
	NHV=18	Q	34
	C4=1.273	Q	35
	G=1.	Q	36
	NICN(2)=NY	Q	37
	IF (IOPT.EQ.2) GO TO 1	Q	38
	TB(1)=TEE(1)	Q	39
1	DO 15 I=1,NY	Q	40
	PRESS=PRES(I)	Q	41
	IF (IOPT.EQ.2) GO TO 2	Q	42

	TB(2)=TB(1)	Q	43
	GO TO 3	Q	44
2	TB(2)=TB(1)*1.2	Q	45
	HS=HH(I)	Q	46
3	I1=0	Q	47
	IF (I.EQ.1) GO TO 5	Q	48
4	Z=29.*PRESS/(82.057*TB(2)*RHO)	Q	49
	IF (Z.LE.1.5) GO TO 6	Q	50
5	CALL HTP (IZW)	Q	51
	IZW=IZW	Q	52
	GO TO 7	Q	53
6	CALL LTP (IZW)	Q	54
	IZW=IZW	Q	55
7	CALL FEMP (IHELP, IOPT)	Q	56
	IF (IOPT.EQ.2) GO TO 8	Q	57
	TB(2)=TEE(I)	Q	58
	TB(1)=TB(2)	Q	59
	GO TO 9	Q	60
8	TEE(I)=TB(2)	Q	61
	HS=HH(I)	Q	62
	TB(1)=TB(2)/1.2	Q	63
9	IF (IHELP.EQ.0) GO TO 10	Q	64
	WRITE (6,17) I,PRESS,HS,TB(1),TB(2)	Q	65
	STOP	Q	66
10	IF (I1.NE.0) GO TO 11	Q	67
	I1=1	Q	68
	GO TO 4	Q	69
11	IF (IZW.EQ.2) GO TO 12	Q	70
	XNN(1,I)=0	Q	71
	XNN(2,I)=FLUT(BMT(3),W3(3),RHO)	Q	72
	XNN(3,I)=FLUT(BMT(2),W3(2),RHO)	Q	73
	XNN(4,I)=0.	Q	74
	XNN(5,I)=0.	Q	75
	XNN(6,I)=FLUT(BMT,W3,RHO)	Q	76
	XNN(7,I)=FLUT(BMT(4),W3(4),RHO)	Q	77
	GO TO 14	Q	78
12	DO 13 L=1,4	Q	79
13	XNN(L,I)=FLUT(BMT(L+2),W3(L+2),RHO)	Q	80
	XNN(5,I)=FLUT(BMT,W3,RHO)	Q	81
	XNN(6,I)=0.	Q	82
	XNN(7,I)=FLUT(BMT(2),W3(2),RHO)	Q	83
14	TB(2)=TEE(I)	Q	84
	RHOND=RHO/RHOIN	Q	85

	IF (KETEST.NE.KEKONT) GO TO 15	Q	86
	IF (MOD(I-1,50).EQ.0) WRITE (6,18)	Q	87
	WRITE (6,19) YY(I),PRES(I),TEE(I),HS,RHO,RHOND	Q	88
15	CONTINUE	Q	89
	C2=DELTD*FL1	Q	90
	C1=DELTD*FL2	Q	91
	C3=C1/3.1416	Q	92
	C5=C1	Q	93
	EP=.001	Q	94
	DO 16 L=1,NIC	Q	95
	IY=NICN(L)	Q	96
	IYCON=IY	Q	97
	YDEL=YY(IY)	Q	98
	CALL CONTM	Q	99
	CALL LINE	Q	100
16	CONTINUE	Q	101
	QRYD=-(1.E7*(QRYPC(1)+QRYPL(1))/(RHOIN*UIN**3))	Q	102
	QRY1=1.E7*(QRYPC(NY)+QRYPL(NY))/(RHOIN*UIN**3)	Q	103
	RETURN	Q	104
C		Q	105
C		Q	106
17	FORMAT (10H1FEMP BLEW,I10,4E20.6)	Q	107
18	FORMAT (14H0 PATH LENGTH,4X,8HPRESSURE,3X,11HTEMPERATURE,4X,8HENT	Q	108
	1HALPY,5X,7HDENSITY,7X,11HDENSITY(ND),/,4X9H(Y/DELTA),9X,5H(ATM),7X	Q	109
	2,7H(DEG K),6X,8H(CAL/GM),5X,7H(GM/CC))	Q	110
19	FORMAT (6X6E13.5)	Q	111
	END	Q	112-

C
C

SUBROUTINE LINE		R	
		1	
		2	
		3	
	COMMON /WON/ QRYPC(20),QRYPL(20)	4	
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	5	
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	6	
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	7	
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	8	
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	9	
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	10	
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	11	
	COMMON /RAD/ XXN(7,100)	12	
	COMMON /RAD/ NDD,FDD(50),AHV(50),AHVL(20)	13	
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	14	
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	15	
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	16	
	1HVM(20),FHVP(20)	17	
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	18	
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	19	
	DIMENSION NICN(100)	20	
	DIMENSION PRES(100)	21	
	DIMENSION HH(100)	22	
	DIMENSION BEE(100),WWM(100),WP(100),FMU(100),T2(100),SS(100),	23	
	1 TAU(100)	24	
	DIMENSION FX1(20),FY1(20)	25	
	DIMENSION WA(100),WS(100)	26	
	DIMENSION FX(20),FY(20)	27	
	DIMENSION IWP(100),IWM(100)	28	
	IYCON=IY	29	
	G=1.	30	
	C9=2.42E14	31	
	C11=1./2.42E14	32	
	FIP=0.	33	
	FIM=0.	34	
	K2=0	35	
	DO 21 K=1,NHV	36	
	FX(K)=0.	37	
	FY(K)=0.	38	
	FX1(K)=0.	39	
	FY1(K)=0.	40	
	K1=K2+1	41	
	K2=K2+NU(K)	42	

	DO 1 I=1,NY	R	43
	T1=TEE(I)*8.62E-5	R	44
	BEE(I)=0.	R	45
	QW=FHV(K)/T1	R	46
	IF (QW.LT.85.) BEE(I)=5040.*FHV(K)**3/(EXP(QW)-1.)	R	47
	WWM(I)=0.	R	48
	WP(I)=0.	R	49
1	CALL MU (FHV(K),T1,XXN(1,I),FMU(I))	R	50
	CALL TRAP (NY,YY,FMU,C2,TAU)	R	51
	X1=FHVM(K)	R	52
	X2=FHVP(K)	R	53
	QF=FLOAT(NU(K))	R	54
	DO 16 J=K1,K2	R	55
	IJ=J-K1+1	R	56
	T2(1)=0.	R	57
	SS(1)=0.	R	58
	F2(1,IJ)=0.	R	59
	BIJ(1,IJ)=0.0	R	60
	DO 5 I=1,NY	R	61
	T1=TEE(I)*8.62E-5	R	62
	E1=1.-EXP(-FHV(K)/T1)	R	63
	J1=ND(J)	R	64
	IF (J1.EQ.7) GO TO 2	R	65
	PN=XXN(2,I)+XXN(4,I)	R	66
	FN=PN/(4.+10.*EXP(-2.384/T1)+6.*EXP(-3.576/T1))	R	67
	GO TO 3	R	68
2	PNP=XXN(1,I)+XXN(3,I)	R	69
	FN=PNP/(7.+5.*EXP(-1.9/T1))	R	70
3	FN=FN*GEE(J1)*EXP(-EPS(J1)/T1)	R	71
	S1=FN*FF(J)*.0266*E1	R	72
	GAM=(GAMP(J)*G*XXN(5,I)*(T1**.25)+1.0E-06)*C9	R	73
	IF (I.EQ.1) GO TO 4	R	74
	DY=.5*(YY(I)-YY(I-1))	R	75
	T2(I)=T2(I-1)+DY*(S1/GAM+OS1/OGAM)*C3	R	76
	SS(I)=SS(I-1)+DY*(S1+OS1)*C1	R	77
	F2(I,IJ)=F2(I-1,IJ)+DY*(S1*GAM+OS1*OGAM)*C5	R	78
	BIJ(I,IJ)=BIJ(I-1,IJ)+DY*(GAM+OGAM)*4.135E-15	R	79
4	OS1=S1	R	80
	OGAM=GAM	R	81
5	CONTINUE	R	82
	IF (IY.EQ.1) GO TO 11	R	83
	DO 8 I=1,IY	R	84
	FINT=T2(IY)-T2(I)	R	85

	IF (FINT.GT.C4) GO TO 6	R 86
	WS(I)=(SS(IY)-SS(I))*C11	R 87
	F(I,IJ)=0.	R 88
	GO TO 7	R 89
6	WS(I)=2.*SQRT(F2(IY,IJ)-F2(I,IJ))*C11	R 90
	F(I,IJ)=1.	R 91
7	WWM(I)=WWM(I)+WS(I)	R 92
	IF (I.EQ.IY) GO TO 9	R 93
8	GMIN(I,IJ)=((BIJ(IY,IJ)-BIJ(I,IJ))/(YY(IY)-YY(I)))*2	R 94
	GO TO 10	R 95
9	GMIN(I,IJ)=0	R 96
10	IF (IY.EQ.NY) GO TO 16	R 97
11	DO 15 I=IY,NY	R 98
	FINT=T2(I)-T2(IY)	R 99
	IF (FINT.GT.C4) GO TO 12	R 100
	WA(I)=(SS(I)-SS(IY))*C11	R 101
	F(I,IJ)=0.	R 102
	GO TO 13	R 103
12	WA(I)=2.*SQRT(F2(I,IJ)-F2(IY,IJ))*C11	R 104
	F(I,IJ)=1.	R 105
13	WP(I)=WP(I)+WA(I)	R 106
	IF (I.EQ.NY) GO TO 14	R 107
	GPLU(I,IJ)=((BIJ(I,IJ)-BIJ(NY,IJ))/(YY(I)-YY(NY)))*2	R 108
	GO TO 15	R 109
14	GPLU(I,IJ)=0	R 110
15	CONTINUE	R 111
16	CONTINUE	R 112
	IF (IY.EQ.1) GO TO 18	R 113
	IFL=1	R 114
	DO 17 I=1,IY	R 115
	IWM(I)=0	R 116
	IF (WWM(I)/QF.LT.WOL(K)) GO TO 17	R 117
	IWM(I)=1	R 118
	IQ1=I	R 119
	IAED=1	R 120
	CALL HAFA (1,X1,X2)	R 121
	CALL HAFA (2,0.,0.)	R 122
	WWM(I)=WMI	R 123
17	WWM(I)=WWM(I)*EXP(TAU(I)-TAU(IY))	R 124
	CALL TRAP1 (IY,WWM,BEE,-1.,FX(K))	R 125
	FX1(K)=WWM(1)	R 126
	FX(K)=FX(K)*AHVL(K)	R 127
	FIM=FIM+FX(K)	R 128

18	N1=NY-IY+1	R 129
	IF (N1.EQ.1) GO TO 20	R 130
	IFL=-1	R 131
	DO 19 I=IY,NY	R 132
	IWP(I)=0	R 133
	IF (WP(I)/QF.LT.WOL(K)) GO TO 19	R 134
	IWP(I)=1	R 135
	IQ1=I	R 136
	IAED=2	R 137
	CALL HAFACE (1,X1,X2)	R 138
	CALL HAFACE (2,0.,0.)	R 139
	WP(I)=WMI	R 140
19	WP(I)=WP(I)*EXP(TAU(IY)-TAU(I))	R 141
	CALL TRAP1 (N1,WP(IY),BEE(IY),1.,FY(K))	R 142
	FY1(K)=WP(NY)	R 143
	FY(K)=FY(K)*AHVL(K)	R 144
	FIP=FIP+FY(K)	R 145
20	CONTINUE	R 146
21	CONTINUE	R 147
	QRYPL(IY)=FIM+FIP	R 148
	RETURN	R 149
	END	R 150-

C	SUBROUTINE CONTM	S	1
	COMMON /WON/ QRYPC(20),QRYPL(20)	S	2
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	S	3
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	S	4
	2E(16),RA(16,2),RBD(16,2),RC(16,2),RD(16,2),RDI(16,2),RE(16,2),REI(	S	5
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	S	6
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	S	7
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	S	8
	COMMON /RAD/ YY(100),TEE(100),DUN(20),NDV,NY,C2,IY	S	9
	COMMON /RAD/ XXN(7,100)	S	10
	COMMON /RAD/ NHV,FHV(50),AHV(50),AHVL(20)	S	11
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	S	12
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	S	13
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	S	14
	1HVM(20),FHVP(20)	S	15
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	S	16
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	S	17
	DIMENSION NICN(100)	S	18
	DIMENSION PRES(100)	S	19
	DIMENSION HH(100)	S	20
	DIMENSION FMU(100),TAU(100),FIM(40),FIP(40),BEE(100),EM(100),	S	21
	1 EEP(100),FIIP(40),FIIM(40)	S	22
	DO 9 K=1,NHV	S	23
	DO 1 I=1,NY	S	24
	T1=TEE(I)*8.62E-5	S	25
	CALL MU (FHV(K),T1,XXN(1,I),FMU(I))	S	26
	BEE(I)=0.	S	27
	AQ=FHV(K)/T1	S	28
	IF (AQ.LT.85.) BEE(I)=5040.*FHV(K)**3/(EXP(AQ)-1.)	S	29
1	CONTINUE	S	30
	CALL TRAP (NY,YY,FMU,C2,TAU)	S	31
	IF (IY.NE.1) GO TO 2	S	32
	FIM(K)=0.	S	33
	GO TO 4	S	34
2	DO 3 I=1,IY	S	35
3	EM(I)=1.-EXP(TAU(I)-TAU(IY))	S	36
	CALL TRAP1 (IY,EM,BEE,-1.,FIM(K))	S	37
	FIM(K)=FIM(K)*AHV(K)	S	38
4	N1=NY-IY+1	S	39
	IF (N1.NE.1) GO TO 5	S	40
	FIP(K)=0.	S	41
		S	42

	GO TO 7	S	43
5	DO 6 I=IY,NY	S	44
6	EEP(I)=1.-EXP(TAU(IY)-TAU(I))	S	45
	CALL TRAP1 (N1,EEP(IY),BEE(IY),1.,FIP(K))	S	46
	FIP(K)=FIP(K)*AHV(K)	S	47
7	IF (K.NE.1) GO TO 8	S	48
	FIIM(1)=0.	S	49
	FIIP(1)=0.	S	50
	GO TO 9	S	51
8	CALL TRAP (K,FHV,FIM,1.,FIIM)	S	52
	CALL TRAP (K,FHV,FIP,1.,FIIP)	S	53
9	CONTINUE	S	54
	QRYPC(IY)=FIIM(NHV)+FIIP(NHV)	S	55
	RETURN	S	56
	END	S	57-

	SUBROUTINE MU (HV,XKT,XM,XAPNU)	T	1
	DIMENSION XKT(1), XNN(1), XNO(1), XNI(1), XNO2(1), XNN2(1), XAPNU(	T	2
	11,1), XM(1)	T	3
	SQA=7.25E-16	T	4
	XNN(1)=XM(4)	T	5
	XNO(1)=XM(2)	T	6
	XNI(1)=XM(1)+XM(3)	T	7
	XNO2(1)=XM(6)	T	8
	XNN2(1)=XM(7)	T	9
	L=1	T	10
	I=1	T	11
	XMOL=1.	T	12
	BQ7=0.	T	13
	CALL ZHV (HV,ZO,ZN,ZI,ZC)	T	14
	XN=14.3/XKT(I)	T	15
	XO=13.4/XKT(I)	T	16
	XI=25.5/XKT(I)	T	17
	XX=HV/XKT(I)	T	18
	EQ1=SQA*XNN(I)*XKT(I)*4.5*EXP(-XN+XX)*ZN/HV**3	T	19
	EQ2=SQA*XNO(I)*XKT(I)*0.88888889*EXP(-XO+XX)*ZO/HV**3	T	20
	EQ3=SQA*XNI(I)*XKT(I)*4.0*1.33*EXP(-XI+XX)*ZI/HV**3	T	21
	BQ5=XMOL*XNO2(I)*400.0*SQRT(TANH(0.0975/XKT(I)))*EXP(-TANH(0.195/(	T	22
	12.0*XKT(I)))*((HV-8.56)/0.805)**2)/2.687E+19	T	23
	BQ6=XMOL*XNN2(I)*1.2E-17*EXP(-ABS(HV-13.6+(1.0-0.603/XKT(I)))*1.3	T	24
	1)	T	25
	EQ4=EQ1*EXP(4.22/XKT(I)-XX)	T	26
	EQ5=EQ2*EXP(4.22/XKT(I)-XX)	T	27
	EQ7=EQ3*EXP(11.2/XKT(I)-XX)	T	28
	EQ9=EQ5+XNO(I)*3.6E-17/(9.0+5.0*EXP(-1.98/XKT(I))+EXP(-4.18/XKT(I)	T	29
	1))	T	30
	EPC=1.0-EXP(-XX)	T	31
	IF (HV-4.22) 1,1,2	T	32
1	XAPNU(L,I)=EPC*(EQ1+EQ2+EQ3)	T	33
	GO TO 17	T	34
2	IF (HV-10.8) 3,3,8	T	35
3	XAPNU(L,I)=EPC*(EQ4+EQ5+EQ3)	T	36
	IF (HV-7.0) 17,4,4	T	37
4	IF (HV-9.2) 5,5,6	T	38
5	XAPNU(L,I)=XAPNU(L,I)+BQ5+BQ7	T	39
	GO TO 17	T	40
6	IF (HV-10.0) 7,7,17	T	41
7	XAPNU(L,I)=XAPNU(L,I)+BQ7	T	42

	GO TO 17	T	43
8	IF (HV-12.0) 9,9,11	T	44
9	XAPNU(L,I)=EPC*(EQ4+XNN(I)*5.16E-17*EXP(-XN+10.8/XKT(I))/(4.0+10.0	T	45
	1*EXP(-2.38/XKT(I))+6.0*EXP(-3.57/XKT(I)))+EQ5+EQ7)	T	46
	IF (HV-11.0) 17,10,10	T	47
10	XAPNU(L,I)=XAPNU(L,I)+BQ6	T	48
	GO TO 17	T	49
11	IF (HV-13.4) 12,12,13	T	50
12	XAPNU(L,I)=EPC*(EQ4+(5.16E-17*XNN(I)*EXP(-XN+10.8/XKT(I))+XNN(I)*6	T	51
	1.4E-17*EXP(-XN+12.0/XKT(I)))/(4.0+10.0*EXP(-2.38/XKT(I))+6.0*EXP(-	T	52
	23.57/XKT(I)))+EQ5+EQ7)+BQ6	T	53
	GO TO 17	T	54
13	IF (HV-14.3) 14,14,16	T	55
14	XAPNU(L,I)=EPC*(EQ4+(5.16E-17*XNN(I)*EXP(-XN+10.8/XKT(I))+XNN(I)*6	T	56
	1.4E-17*EXP(-XN+12.0/XKT(I)))/(4.0+10.0*EXP(-2.38/XKT(I))+6.0*EXP(-	T	57
	23.57/XKT(I)))+EQ9+EQ7)	T	58
	IF (HV-14.2) 15,15,17	T	59
15	XAPNU(L,I)=XAPNU(L,I)+BQ6	T	60
	GO TO 17	T	61
16	XAPNU(L,I)=EPC*(EQ4+(5.16E-17*XNN(I)*EXP(-XN+10.8/XKT(I))+XNN(I)*6	T	62
	1.4E-17*EXP(-XN+12.0/XKT(I))+3.16E-17*XNN(I))/(4.0+10.0*EXP(-2.38/X	T	63
	2KT(I))+6.0*EXP(-3.57/XKT(I)))+EQ9+EQ7)	T	64
17	CONTINUE	T	65
	RETURN	T	66
	END	T	67-

	SUBROUTINE FEMP (IHHELP, IOPT)	U	1
C		U	2
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	U	3
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	U	4
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	U	5
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(15),VNT(17),VNU(1	U	6
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	U	7
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	U	8
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	U	9
	COMMON /RAD/ XNN(7,100)	U	10
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	U	11
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	U	12
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	U	13
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	U	14
	1HVM(20),FHVP(20)	U	15
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	U	16
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	U	17
	DIMENSION NICN(100)	U	18
	DIMENSION PRES(100)	U	19
	DIMENSION HH(100)	U	20
	DIMENSION TGUS(15), DIG(15)	U	22
	DIMENSION FFF(3)	U	23
	IHHELP=0	U	24
	W27=0.0	U	25
	DO 1 J=1,IS	U	26
1	W27=W27+ALP(J)*W26(J)	U	27
	IF (IOPT.EQ.1) GO TO 2	U	28
	HS=HS*W27	U	29
2	CONTINUE	U	30
	DO 8 I=1,N	U	31
	K=1	U	32
	DO 5 KS=1,IS	U	33
	IF (JAT(I,K)-KAT(KS)) 6,3,4	U	34
3	C(KS,I)=ALPT(I,K)	U	35
	K=K+1	U	36
	GO TO 5	U	37
4	C(KS,I)=0.0	U	38
5	CONTINUE	U	39
	GO TO 8	U	40
6	DO 7 LS=KS,IS	U	41
7	C(LS,I)=0.0	U	42
8	CONTINUE	U	43

	DO 13 I=1,N	U	44
	DO 11 J=1,2	U	45
	IF (KODE(I)-1) 9,9,10	U	46
9	CH(I,J)=RA(I,J)+RBO(I,J)	U	47
	GO TO 11	U	48
10	CH(I,J)=RA(I,J)	U	49
11	CONTINUE	U	50
	W3(I)=0.0	U	51
	DO 12 LS=1,IS	U	52
12	W3(I)=W3(I)+C(LS,I)*W26(LS)	U	53
13	CONTINUE	U	54
	IG=N	U	55
	IF (ION) 18,18,14	U	56
14	DO 15 I=1,IG	U	57
15	VNE(I)=0.0	U	58
	DO 17 I=2,IG	U	59
	DO 16 KS=2,IS	U	60
16	VNE(I)=VNE(I)+C(KS,I)*DEGI(KS)	U	61
17	VNE(I)=VNE(I)+C(1,I)*DEGI(1)	U	62
18	NP=N+1	U	63
	ISP=IS+1	U	64
	IGMS=IG-IS	U	65
	IGMSP=IGMS+1	U	66
	NG=0	U	67
	ISPNG=IS+NG	U	68
	ISPNGP=ISPNG+1	U	69
	ISPNG2=ISPNGP+1	U	70
	IGP=IG+1	U	71
	DO 19 I=1,N	U	72
19	JPH(I)=0	U	73
	DO 20 I=1,IS	U	74
	DO 20 K=1,IS	U	75
	J=IG-IS+K	U	76
20	A(K,I)=C(I,J)	U	77
	CALL INVERT (IS,A)	U	78
	DO 22 K=1,IGMS	U	79
	DO 22 J=1,IS	U	80
	VNU(K,J)=0.0	U	81
	DO 21 I=1,IS	U	82
21	VNU(K,J)=VNU(K,J)+A(I,J)*C(I,K)	U	83
22	CONTINUE	U	84
	DO 23 I=1,NP	U	85
23	VNT(I)=0.	U	86

	VN(NP)=AMAX1(VNT(NP),0.02)	U	87
	DO 24 I=1,N	U	88
	VN(I)=VNT(NP)*VNT(I)	U	89
24	VN(I)=AMAX1(VN(I),1.0E-06)	U	90
	DO 27 I=1,IGMS	U	91
	DO 25 J=1,IS	U	92
25	A12(I,J)=-VNU(I,J)	U	93
	DO 26 K=ISP,ISPNGP	U	94
26	A12(I,K)=0.0	U	95
27	CONTINUE	U	96
	DO 28 I=ISP,ISPNGP	U	97
	DO 28 J=ISP,ISPNGP	U	98
28	A22(I,J)=0.0	U	99
	IA=1	U	100
	JA=1	U	101
	IX=1	U	102
29	TBJA=TB(JA)	U	103
	CALL EQUIL (TBJA,PRESS,IX,N2P,.FALSE.)	U	104
	TB(JA)=TBJA	U	105
	IF (IX-1) 30,31,30	U	106
30	WRITE (6,60) TBJA	U	107
31	VA=0.0	U	108
	DO 32 I=1,N	U	109
32	VA=VA+H(I)*VN(I)	U	110
	HSB=VA/VN(NP)	U	111
	GO TO (33,34), IOPT	U	112
33	HS=HSB/W27	U	113
	FN SN 36	T	113
34	FFF(JA)=HSB-HS	U	115
	TGUS(IA)=TBJA	U	116
	DIG(IA)=FFF(JA)	U	117
	IF (JA-2) 35,36,36	U	118
35	JA=JA+1	U	119
	GO TO 29	U	120
36	IF (ABS(FFF(2)/HS)-1.0E-04) 47,47,37	U	121
37	IF (FFF(1)-FFF(2)) 38,39,38	U	122
38	TP=TB(1)+(FFF(1)/(FFF(1)-FFF(2)))*(TB(2)-TB(1))	U	123
	GO TO 40	U	124
39	TP=TB(1)	U	125
40	IF (TP) 41,41,42	U	126
41	TP=0.75*TB(1)	U	127
42	FFF(1)=FFF(2)	U	128
	TB(1)=TB(2)	U	129

	TB(2)=TP	U 130
	IF (IA-10) 46,46,43	U 131
43	WRITE (6,61) HS,(TGUS(LK),DIG(LK),LK=1,IA)	U 132
	IMIN=1	U 133
	DO 45 IX=2,11	U 134
	IF (ABS(DIG(IX))-ABS(DIG(IMIN))) 44,44,45	U 135
44	IMIN=IX	U 136
45	CONTINUE	U 137
	TB(2)=TGUS(IMIN)	U 138
	GO TO 47	U 139
46	IA=IA+1	U 140
	GO TO 29	U 141
47	TB2=TB(2)	U 142
	CALL EQUIL (TB2,PRESS,IX,N2P,.TRUE.)	U 143
	TB(2)=TB2	U 144
	VA=0.0	U 145
	VB=0.0	U 146
	VC=0.0	U 147
	VD=0.0	U 148
	VE=0.0	U 149
	VF=1.0/TB(2)**2	U 150
	DO 57 I=1,N	U 151
	J=1	U 152
	IF (TU(I,1)-TB(2)) 48,49,49	U 153
48	J=2	U 154
49	IF (KODE(I)-1) 50,53,50	U 155
50	J=1	U 156
	IF (TU2(I,J)-TB(2)) 51,52,52	U 157
51	J=2	U 158
52	CP(I)=1.98726*(RD1(I,J)*TB(2)-2.0*RE1(I,J)*VF)	U 159
	GO TO 54	U 160
53	CP(I)=RC(I,J)+RD(I,J)*TB(2)+RE(I,J)*VF	U 161
54	VA=VA+CP(I)*VN(I)	U 162
	VC=VC+VN(I)	U 163
	IF (I-IG) 56,55,56	U 164
55	VB=VC	U 165
56	VG=VN(I)*W3(I)	U 166
57	VD=VD+VG	U 167
	WM=VD/(VB+VE/(82.0597*TB(2)))	U 168
	RHO=(PRESS*WM)/(82.0597*TB(2))	U 169
	VNT(NP)=VN(NP)	U 170
	DO 58 I=1,N	U 171
58	VNT(I)=VN(I)/VN(NP)	U 172

	SYU=0.0	U 173
	DO 59 M=1,N	U 174
	BMT(M)=(VNT(M)*W3(M))/W27	U 175
59	SYU=SYU+BMT(M)	U 176
	RETURN	U 177
C		U 178
C		U 179
60	FORMAT (21HON-R DID NOT CONVERGE,E15.5)	U 180
61	FORMAT (19HOT DID NOT CONVERGE,E15.5// (2E15.5))	U 181
	END	U 182-

	SUBROUTINE DEFIOJ (N,IS,C,VN,JPH,IOJ)	V	1
	DIMENSION C(6,16), VN(17), JPH(16), IOJ(13), X(20), CT(20), V(16),	V	2
1	TAU(7,7), P(20,20), IL(16), IPH(16)	V	3
	EQUIVALENCE (X,CT)	V	4
	LN=N	V	5
	LS=IS	V	6
	LNP=LN+1	V	7
	LSP=LS+1	V	8
	DO 1 I=1, LN	V	9
1	V(I)=VN(I)	V	10
	CALL ORDERV (LN,V,IPH)	V	11
	M=LN/2	V	12
	DO 2 J=1, M	V	13
	K=LN+1-J	V	14
	II=IPH(J)	V	15
	IPH(J)=IPH(K)	V	16
2	IPH(K)=II	V	17
	L=1	V	18
	DO 10 K=1, LN	V	19
	IND=IPH(K)	V	20
	IF (JPH(IND)) 3,3,10	V	21
3	DO 4 I=1, LS	V	22
4	TAU(L,I)=C(I,IND)	V	23
	DO 6 I=1, L	V	24
	TP=0.0	V	25
	DO 5 J=1, LS	V	26
5	TP=TP+TAU(I,J)*TAU(L,J)	V	27
	P(I,L)=TP	V	28
6	P(L,I)=TP	V	29
	DO 7 I=1, 20	V	30
	CT(I)=0	V	31
7	CONTINUE	V	32
	CALL DTLNEQ (L,P,CT,X,DET)	V	33
	IF (ABS(DET)-1.0E-05) 10,10,8	V	34
8	IL(L)=IND	V	35
	IF (L-LS) 9,11,11	V	36
9	L=L+1	V	37
10	CONTINUE	V	38
11	CALL ORDERI (LS,IL)	V	39
	IOJ(LSP)=LNP	V	40
	DO 12 J=1, LS	V	41
12	IOJ(J)=IL(J)	V	42
	RETURN	V	43
	END	V	44-

	SUBROUTINE ORDERI (N,IPH)	W	1
	DIMENSION IPH(16)	W	2
1	K=0	W	3
	DO 3 J=2,N	W	4
	IF (IPH(J-1)-IPH(J)) 3,3,2	W	5
2	IT=IPH(J-1)	W	6
	IPH(J-1)=IPH(J)	W	7
	IPH(J)=IT	W	8
	K=1	W	9
3	CONTINUE	W	10
	IF (K) 4,4,1	W	11
4	RETURN	W	12
	END	W	13-

	SUBROUTINE ORDERV (N,V,IPH)	X	1
	DIMENSION V(16), IPH(16)	X	2
	LN=N	X	3
	DO 1 I=1, LN	X	4
1	IPH(I)=I	X	5
2	K=0	X	6
	DO 4 J=2, LN	X	7
	IF (V(J-1)-V(J)) 4,4,3	X	8
3	VT=V(J-1)	X	9
	V(J-1)=V(J)	X	10
	V(J)=VT	X	11
	IT=IPH(J-1)	X	12
	IPH(J-1)=IPH(J)	X	13
	IPH(J)=IT	X	14
	K=1	X	15
4	CONTINUE	X	16
	IF (K) 5,5,2	X	17
5	RETURN	X	18
	END	X	19-

	SUBROUTINE INVERT (N,A)	Y	1
	DIMENSION A(6,6), ZM(6,6), N7(6), N9(6)	Y	2
	EQUIVALENCE (N9(1),N7(2))	Y	3
	DO 3 I=1,N	Y	4
	DO 3 J=1,N	Y	5
	IF (I-J) 2,1,2	Y	6
1	ZM(I,J)=1.0	Y	7
	GO TO 3	Y	8
2	ZM(I,J)=0.0	Y	9
3	CONTINUE	Y	10
	N7(1)=0	Y	11
	DO 15 I=1,N	Y	12
	Z3=0.0	Y	13
	DO 6 J=1,N	Y	14
	DO 4 K=1,I	Y	15
	IF (J-N7(K)) 4,6,4	Y	16
4	CONTINUE	Y	17
	V=ABS(A(J,I))	Y	18
	IF (V-Z3) 6,6,5	Y	19
5	Z3=V	Y	20
	N9(I)=J	Y	21
	L=J	Y	22
6	CONTINUE	Y	23
	IF (Z3-1.0E-07) 7,7,8	Y	24
7	Z3=1.0E-07	Y	25
8	V=A(L,I)	Y	26
	DO 10 J=1,N	Y	27
	ZM(L,J)=ZM(L,J)/V	Y	28
	IF (J-I) 10,10,9	Y	29
9	A(L,J)=A(L,J)/V	Y	30
10	CONTINUE	Y	31
	DO 14 J=1,N	Y	32
	IF (J-L) 11,14,11	Y	33
11	V=-A(J,I)	Y	34
	DO 13 K=1,N	Y	35
	ZM(J,K)=ZM(J,K)+V*ZM(L,K)	Y	36
	IF (K-I) 13,13,12	Y	37
12	A(J,K)=A(J,K)+V*A(L,K)	Y	38
13	CONTINUE	Y	39
14	CONTINUE	Y	40
15	CONTINUE	Y	41
	DO 16 I=1,N	Y	42
	J=N9(I)	Y	43
	DO 16 K=1,N	Y	44
16	A(I,K)=ZM(J,K)	Y	45
	RETURN	Y	46
	END	Y	47-

	SUBROUTINE EQUIL (TE,PR,IX,N2P,DOCB)	Z	1
	LOGICAL DOCB	Z	2
C		Z	3
C		Z	4
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	Z	5
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	Z	6
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	Z	7
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	Z	8
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	Z	9
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	Z	10
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	Z	11
	COMMON /RAD/ XNN(7,100)	Z	12
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	Z	13
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	Z	14
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	Z	15
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	Z	16
	1HVM(20),FHVP(20)	Z	17
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	Z	18
	11,WMI,8IJ(100,10),GMIN(100,10),GPLU(100,10),IAED	Z	19
	DIMENSION NICN(100)	Z	20
	DIMENSION PRES(100)	Z	21
	DIMENSION HH(100)	Z	22
	DIMENSION DMU(16),VLNK(16),STEP(17),EZ(17),AA(6),A21(7,17),A	Z	24
	1T(20,20),B(20),IOJ(13),XB(20),XX(20),DY(17)	Z	25
	EQUIVALENCE (XB,XX)	Z	26
	KCBAL=0	Z	27
	IF (DOCB) GO TO 54	Z	28
	VA=ALOG(TE/3000.)	Z	29
	VB=TE-3000.	Z	30
	VC=(TE+3000.)/2.0	Z	31
	VD=1.0/(TE*3000.)	Z	32
	VE=VC*VD**2	Z	33
	JC=1	Z	34
	JD=1	Z	35
	VF=0.0	Z	36
	KERRSV=KERR	Z	37
	KERR=1	Z	38
	DO 1 I=1,IG	Z	39
1	VF=VF+VN(I)	Z	40
	IF (VF-PR) 2,4,2	Z	41
2	VF=PR/VF	Z	42
	DO 3 I=1,NP	Z	43

3	VN(I)=VF*VN(I)	Z	44
4	DO 5 I=1,IG	Z	45
5	Y(I)=ALOG(VN(I))	Z	46
	DO 14 I=1,N	Z	47
	J=1	Z	48
	IF (TE-TU(I,J)) 7,7,6	Z	49
6	J=2	Z	50
7	IF (KODE(I)-1) 8,8,9	Z	51
8	H(I)=CH(I,J)+VB*(RC(I,J)+RD(I,J)*VC+RE(I,J)*VD)	Z	52
	SD(I)=RF(I,J)+RC(I,J)*VA+VB*(RD(I,J)+RE(I,J)*VE)	Z	53
	DMU(I)=H(I)-TE*SD(I)	Z	54
	GO TO 14	Z	55
9	J=1	Z	56
	IF (TE-TU(I,J)) 11,11,10	Z	57
10	J=2	Z	58
11	DMU(I)=CH(I,J)-1.98726*(RC(I,J)*TE+RD(I,J)*TE**2+RE(I,J)/TE)	Z	59
	J=1	Z	60
	IF (TE-TU2(I,J)) 13,13,12	Z	61
12	J=2	Z	62
13	SD(I)=1.98726*(RC1(I,J)+RD1(I,J)*TE+RE1(I,J)/TE**2)	Z	63
	H(I)=DMU(I)+TE*SD(I)	Z	64
14	CONTINUE	Z	65
	VA=-1.0/(1.98726*TE)	Z	66
	DO 16 I=1,IGMS	Z	67
	VB=0.0	Z	68
	DO 15 LS=1,IS	Z	69
	J=IGMS+LS	Z	70
15	VB=VB+VNU(I,LS)*DMU(J)	Z	71
16	VLNK(I)=VA*(DMU(I)-VB)	Z	72
	CALL DEFIOJ (N,IS,C,VN,JPH,IOJ)	Z	73
	CALL MASBAL (VN,IOJ,C,ALP,JC,0.9,IS,N,PR,IG)	Z	74
17	EL=0.0	Z	75
	ENL=0.0	Z	76
	DO 18 I=1,NP	Z	77
18	STEP(I)=1.0	Z	78
	DO 19 I=1,IG	Z	79
19	Y(I)=ALOG(VN(I))	Z	80
	DO 23 I=1,IGMS	Z	81
	VA=0.0	Z	82
	DO 20 LS=1,IS	Z	83
	J=IGMS+LS	Z	84
20	VA=VA+VNU(I,LS)*Y(J)	Z	85
	EZ(I)=VLNK(I)-Y(I)+VA	Z	86

	A12(I,ISPNG2)=EZ(I)	Z 87
	IF (VN(I)-1.0E-30) 21,21,22	Z 88
21	STEP(I)=0.0	Z 89
	EL=AMAX1(EL,EZ(I))	Z 90
	GO TO 23	Z 91
22	EL=AMAX1(EL,ABS(EZ(I)))	Z 92
23	CONTINUE	Z 93
	DO 24 I=1,IS	Z 94
	AA(I)=0.0	Z 95
	DO 24 J=1,IGMS	Z 96
	A21(I,J)=C(I,J)*VN(J)	Z 97
24	AA(I)=AA(I)+A21(I,J)	Z 98
	DO 25 J=1,IGMS	Z 99
25	A21(ISPNGP,J)=VN(J)	Z 100
	DO 26 I=1,IS	Z 101
	DO 26 J=1,ISPNG	Z 102
	K=IGMS+J	Z 103
	A22(I,J)=C(I,K)*VN(K)	Z 104
26	AA(I)=AA(I)+A22(I,J)	Z 105
	DO 27 J=1,IS	Z 106
	K=IGMS+J	Z 107
27	A22(ISPNGP,J)=VN(K)	Z 108
	DO 28 I=1,IS	Z 109
	A22(I,ISPNGP)=-AA(I)	Z 110
	VA=(VN(NP)*ALP(I))/AA(I)	Z 111
	K=IGMS+I	Z 112
	EZ(K)=ALOG(VA)	Z 113
	A22(I,ISPNG2)=AA(I)*EZ(K)	Z 114
	ENL=AMAX1(ENL,ABS(EZ(K)))	Z 115
28	CONTINUE	Z 116
	PB=0.0	Z 117
	DO 29 I=1,IG	Z 118
29	PB=PB+VN(I)	Z 119
	EZ(NP)=ALOG(PR/PB)	Z 120
	A22(ISPNGP,ISPNG2)=PB*EZ(NP)	Z 121
	ENL=AMAX1(ENL,ABS(EZ(NP)))	Z 122
	IF (AMAX1(EL,ENL)-1.0E-05) 54,54,30	Z 123
30	DO 32 I=1,ISPNGP	Z 124
	DO 32 K=1,ISPNGP	Z 125
	VA=0.0	Z 126
	DO 31 J=1,IGMS	Z 127
31	VA=VA+A21(I,J)*A12(J,K)*STEP(J)	Z 128
32	AT(I,K)=A22(I,K)-VA	Z 129

	DO 34 I=1,ISPNGP	Z 130
	VA=0.0	Z 131
	DO 33 J=1,IGMS	Z 132
33	VA=VA+A21(I,J)*A12(J,ISPNG2)	Z 133
34	B(I)=A22(I,ISPNG2)-VA	Z 134
	CALL DTLNEQ (ISPNGP,AT,B,XB,VA)	Z 135
	XX(ISPNG2)=-1.	Z 136
	VB=0.0	Z 137
	DO 37 I=1,ISPNGP	Z 138
	J=IGMS+I	Z 139
	DY(J)=XX(I)	Z 140
	IF (I-IS) 36,36,35	Z 141
35	IF (STEP(J)) 37,37,36	Z 142
36	VB=AMAX1(VB,ABS(XX(I)))	Z 143
37	CONTINUE	Z 144
	DO 41 I=1,IGMS	Z 145
	VA=0.0	Z 146
	DO 38 J=1,ISPNG2	Z 147
38	VA=VA+A12(I,J)*XX(J)	Z 148
	DY(I)=-VA	Z 149
	IF (STEP(I)) 39,39,40	Z 150
39	DY(I)=A12(I,ISPNG2)	Z 151
	GO TO 41	Z 152
40	VB=AMAX1(ABS(VA),VB)	Z 153
41	CONTINUE	Z 154
	IF (VB-2.3052) 44,44,42	Z 155
42	VA=2.3052/VB	Z 156
	DO 43 I=1,NP	Z 157
43	DY(I)=VA*DY(I)	Z 158
44	DO 45 I=1,IG	Z 159
	VN(I)=AMAX1(VN(I)*EXP(DY(I)),1.0E-30)	Z 160
45	CONTINUE	Z 161
	DO 46 I=IGP,NP	Z 162
46	VN(I)=AMAX1(VN(I)*EXP(DY(I)),5.0E-10)	Z 163
	IF (JC-50) 48,48,47	Z 164
47	IX=2	Z 165
	RETURN	Z 166
48	IF (JD-3) 50,49,49	Z 167
49	CALL DEFIOJ (N,IS,C,VN,JPH,IOJ)	Z 168
	JD=1	Z 169
	GO TO 51	Z 170
50	JD=JD+1	Z 171
51	IF ((1.111*ENL)-EL) 53,52,52	Z 172

52	CALL MASBAL (VN,IOJ,C,ALP,JC,0.9,IS,N,PR,IG)	Z 173
53	JC=JC+1	Z 174
	GO TO 17	Z 175
54	IF (.NOT.DOCB) RETURN	Z 176
	IF (ION.EQ.0.OR.IX.EQ.2) RETURN	Z 177
	VNSAVE=0.0	Z 178
	DO 55 M=2,N	Z 179
55	VNSAVE=VNSAVE+VN(M)*VNE(M)	Z 180
	CHGERR=VNSAVE/VN(1)-1.0	Z 181
	IF (ABS(CHGERR)-1.0E-04) 56,56,57	Z 182
56	RETURN	Z 183
57	KCBAL=KCBAL+1	Z 184
	IF (KCBAL.GT.3) RETURN	Z 185
	CALL CHGBAL (TE,PR,KRAP,DMU)	Z 186
	IF (KRAP.EQ.2) RETURN	Z 187
	JC=1	Z 188
	GO TO 17	Z 189
	END	Z 190-

	SUBROUTINE CHGBAL (TE,PR,KRAP,DMU)	AA	1
	REAL KSUBP,LOGKP	AA	2
	DIMENSION ALPTC(16,7), JATC(16,7), DMUCI(16), VNECB(16), VNMN(16),	AA	3
1	DMUCN(16), KSUBP(16), AK(10), INDEX(16), VNOLD(16), DMU(16)	AA	4
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	AA	5
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	AA	6
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	AA	7
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	AA	8
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	AA	9
	5QN,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	AA	10
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	AA	11
	COMMON /RAD/ XNN(7,100)	AA	12
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	AA	13
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	AA	14
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	AA	15
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	AA	16
	IHVM(20),FHVP(20)	AA	17
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	AA	18
11	WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	AA	19
	DIMENSION NICN(100)	AA	20
	DIMENSION PRES(100)	AA	21
	DIMENSION HH(100)	AA	22
	PB=0.0	AA	24
	DO 1 I=1,IG	AA	25
1	PB=PB+VN(I)	AA	26
	J=1	AA	27
	DO 4 I=2,IG	AA	28
	IF (ABS(VNE(I))-1.0E-20) 4,4,2	AA	29
2	DO 3 K=1,5	AA	30
	ALPTC(J,K)=ALPT(I,K)	AA	31
3	JATC(J,K)=JAT(I,K)	AA	32
	DMUCI(J)=DMU(I)	AA	33
	VNECB(J)=VNE(I)	AA	34
	INDEX(J)=I	AA	35
	J=J+1	AA	36
4	CONTINUE	AA	37
	NOION=J-1	AA	38
	DO 5 J=1,NOION	AA	39
5	DMUCN(J)=0.0	AA	40
	DO 9 I=2,IG	AA	41
	IF (ABS(VNE(I))-1.0E-20) 6,6,9	AA	42
6	DO 8 J=1,NOION	AA	43

	JIN=1	AA	44
	JNU=1	AA	45
	IF (JAT(I,1).EQ.0) JNU=2	AA	46
	IF (JATC(J,1).EQ.0) JIN=2	AA	47
7	DIFF=ABS(ALPT(I,JNU)-ALPTC(J,JIN))	AA	48
	IF ((JAT(I,JNU).NE.JATC(J,JIN)).OR.(DIFF.GT.1.0E-20)) GO TO 8	AA	49
	JNU=JNU+1	AA	50
	JIN=JIN+1	AA	51
	IF (MAX0(JNU,JIN).LT.6) GO TO 7	AA	52
	VNMN(J)=VN(I)	AA	53
	DMUCN(J)=DMU(I)	AA	54
8	CONTINUE	AA	55
9	CONTINUE	AA	56
	MISING=0	AA	57
	DO 10 J=1,NOION	AA	58
	IF (ABS(DMUCN(J)).GT.1.0E-10) GO TO 10	AA	59
	MISING=MISING+1	AA	60
	I=INDEX(J)	AA	61
10	CONTINUE	AA	62
	IF (MISING.EQ.0) GO TO 11	AA	63
	CALL DUMP	AA	64
11	RTR=-1.0/(TE*1.98726)	AA	65
	DO 12 J=1,NOION	AA	66
	LOGKP=RTR*(DMUCI(J)-DMUCN(J)+VNECB(J)*DMU(1))	AA	67
	KSUBP(J)=EXP(LOGKP)	AA	68
12	I=INDEX(J)	AA	69
	DO 15 KK=1,5	AA	70
	AK(KK)=0.0	AA	71
	DO 14 J=1,NOION	AA	72
	KVNECB=IFIX(VNECB(J)+0.001)	AA	73
	IF (VNECB(J).LT.0.0) KVNECB=IFIX(VNECB(J)-0.001)	AA	74
	IF ((KK-3)+KVNECB) 14,13,14	AA	75
13	AK(KK)=AK(KK)+VNECB(J)*KSUBP(J)*VNMN(J)	AA	76
14	CONTINUE	AA	77
15	CONTINUE	AA	78
	AK(4)=AK(4)-1.0	AA	79
	XNEW=ABS(VN(1))	AA	80
	KRUDD=1	AA	81
16	DO 18 LL=1,50	AA	82
	L=LL	AA	83
	FOFX=0.0	AA	84
	FPOFX=0.0	AA	85
	X=XNEW	AA	86

	DO 17 KK=1,5	AA 87
	VKK=KK-3	AA 88
	TEST1=VKK*ALOG(X)	AA 89
	TEST2=(VKK-1.0)*ALOG(X)	AA 90
	TERM1=1.0E+36	AA 91
	TERM2=1.0E+36	AA 92
	IF (TEST1.LT.83.0) TERM1=X**VKK	AA 93
	IF (TEST2.LT.83.0) TERM2=X**(VKK-1.0)	AA 94
	FOFX=FOFX+AK(KK)*TERM1	AA 95
17	FPOFX=FPOFX+VKK*AK(KK)*TERM2	AA 96
	XNEW=X-(FOFX/FPOFX)	AA 97
	IF (XNEW.LT.0.0) XNEW=X/2.0	AA 98
	ERROR=1.0-XNEW/X	AA 99
	IF (ABS(ERROR)-1.0E-06) 20,20,18	AA 100
18	CONTINUE	AA 101
19	KRAP=2	AA 102
	RETURN	AA 103
20	IF (XNEW) 21,22,22	AA 104
21	XNEW=ABS(XNEW)	AA 105
	KRUDD=KRUDD+1	AA 106
	IF (KRUDD.GT.2) GO TO 19	AA 107
	GO TO 16	AA 108
22	X=XNEW	AA 109
	VN(1)=X	AA 110
	DO 23 J=1,NOION	AA 111
	I=INDEX(J)	AA 112
	VNOLD(I)=VN(I)	AA 113
	VN(I)=KSUBP(J)*VNMN(J)*X**(-VNECB(J))	AA 114
23	VN(I)=AMAX1(VN(I),9.999E-30)	AA 115
	KRAP=1	AA 116
	RETURN	AA 117
	END	AA 118-

	SUBROUTINE ZHV (HV,ZO,ZN,ZI,ZC)	AB	1
	X=HV	AB	2
	IF (HV-9.82) 1,1,2	AB	3
1	ZO=0.99997956-0.31554804*X+2.8245479E-02*X**2+6.6773283E-03*X**3-3	AB	4
	1.6445854E-03*X**4+8.0580698E-04*X**5-7.7086374E-05*X**6+2.668133E-	AB	5
	206*X**7	AB	6
	GO TO 3	AB	7
2	ZO=(X/9.82)**3	AB	8
3	IF (HV-8.35) 4,4,5	AB	9
4	ZN=1.000148-0.41835346*X+0.16803591*X**2-9.7794579E-02*X**3+3.3546	AB	10
	1351E-02*X**4-5.6093534E-03*X**5+4.515535E-04*X**6-1.4035845E-05*X*	AB	11
	2*7	AB	12
	GO TO 6	AB	13
5	ZN=(X/8.35)**3	AB	14
6	X=HV/4.0	AB	15
	IF (X-6.6) 7,7,8	AB	16
7	ZI=1.0003794-0.29647668*X+7.5052416E-02*X**2-1.7029481E-02*X**3+3.	AB	17
	12795539E-03*X**4-2.1284692E-04*X**5	AB	18
	GO TO 9	AB	19
8	ZI=(X/7.37)**3	AB	20
9	X=HV	AB	21
	IF (X-7.37) 10,10,11	AB	22
10	ZC=0.99743674-0.43418122*X+8.5313141E-02*X**2-1.3939168E-02*X**3+4	AB	23
	1.0385449E-03*X**4-5.4264246E-04*X**5+2.8121261E-05*X**6-3.8835298E	AB	24
	2-07*X**7	AB	25
	GO TO 12	AB	26
11	ZC=(X/7.37)**3	AB	27
12	RETURN	AB	28
	END	AB	29-

	SUBROUTINE LTP (ITSW)	AC	1
		AC	2
C	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	AC	3
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	AC	4
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	AC	5
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	AC	6
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	AC	7
	5DN,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	AC	8
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	AC	9
	COMMON /RAD/ XNN(7,100)	AC	10
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	AC	11
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	AC	12
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	AC	13
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	AC	14
	1HVM(20),FHVP(20)	AC	15
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	AC	16
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	AC	17
	DIMENSION NICN(100)	AC	18
	DIMENSION PRES(100)	AC	19
	DIMENSION HH(100)	AC	20
	ALP(1)=5.5	AC	22
	ALP(2)=1.4375	AC	23
	ITSW=1	AC	24
	ION=0	AC	25
	IS=2	AC	26
	N=4	AC	27
	W26(1)=14.008	AC	28
	W26(2)=16.0	AC	29
	KAT(1)=7	AC	30
	KAT(2)=8	AC	31
	DEGI(1)=0.0	AC	32
	DEGI(2)=0.0	AC	33
	KODE(1)=1	AC	34
	DO 1 J=2,4	AC	35
1	KODE(J)=2	AC	36
	DO 2 J=1,4	AC	37
	DO 2 K=1,5	AC	38
	ALPT(J,K)=0.0	AC	39
2	JAT(J,K)=0	AC	40
	ALPT(1,1)=2.0	AC	41
	JAT(1,1)=8	AC	42
	ALPT(2,1)=1.0	AC	43

JAT(2,1)=1	AC	44
ALPT(3,1)=1.0	AC	45
JAT(3,1)=8	AC	46
ALPT(4,1)=2.0	AC	47
JAT(4,1)=7	AC	48
RA(1,1)=0.0	AC	49
RBO(1,1)=2.55197E+04	AC	50
RC(1,1)=8.12927	AC	51
RD(1,1)=4.85368E-04	AC	52
RE(1,1)=-2.75743E+05	AC	53
RF(1,1)=67.9798	AC	54
TU(1,1)=3000.	AC	55
RA(1,2)=0.0	AC	56
RBO(1,2)=2.55239E+04	AC	57
RC(1,2)=10.2348	AC	58
RD(1,2)=4.5738E-05	AC	59
RE(1,2)=-7.73465E+06	AC	60
RF(1,2)=67.9813	AC	61
TU(1,2)=6000.	AC	62
RA(2,1)=0.1125E+06	AC	63
RC(2,1)=19.8515	AC	64
RD(2,1)=0.650822E-03	AC	65
RE(2,1)=-0.156336E+07	AC	66
TU(2,1)=5000.	AC	67
RA(2,2)=0.1125E+06	AC	68
RC(2,2)=23.2779	AC	69
RD(2,2)=0.190986E-03	AC	70
RE(2,2)=-0.331003E+08	AC	71
TU(2,2)=24000.	AC	72
RC1(2,1)=22.4633	AC	73
RD1(2,1)=0.622485E-03	AC	74
RE1(2,1)=-0.165345E+07	AC	75
TU2(2,1)=6000.	AC	76
RC1(2,2)=26.0356	AC	77
RD1(2,2)=0.229541E-03	AC	78
RE1(2,2)=-0.501696E+08	AC	79
TU2(2,2)=24000.	AC	80
RA(3,1)=0.58985E+05	AC	81
RC(3,1)=20.8169	AC	82
RD(3,1)=0.655447E-03	AC	83
RE(3,1)=-0.162744E+07	AC	84
TU(3,1)=5000.	AC	85
RA(3,2)=0.58985E+05	AC	86


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RC(3,2)=24.5103
RD(3,2)=0.158277E-03
RE(3,2)=-0.351471E+08
TU(3,2)=24000.
RC1(3,1)=23.3381
RD1(3,1)=0.659562E-03
RE1(3,1)=-0.155587E+07
TU2(3,1)=5000.
RC1(3,2)=26.8167
RD1(3,2)=0.186999E-03
RE1(3,2)=-0.322302E+08
TU2(3,2)=24000.
RA(4,1)=0.0
RC(4,1)=24.9173
RD(4,1)=1.08123E-03
RE(4,1)=-2.21576E+06
TU(4,1)=5000.
RA(4,2)=0.0
RC(4,2)=30.6229
RD(4,2)=3.01129E-04
RE(4,2)=-5.19808E+07
TU(4,2)=24000.
RC1(4,1)=28.2374
RD1(4,1)=1.32899E-03
RE1(4,1)=-2.1492E+06
TU2(4,1)=4000.
RC1(4,2)=33.5174
RD1(4,2)=4.39119E-04
RE1(4,2)=-3.14737E+07
TU2(4,2)=24000.
RETURN
END

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AC 87
AC 88
AC 89
AC 90
AC 91
AC 92
AC 93
AC 94
AC 95
AC 96
AC 97
AC 98
AC 99
AC 100
AC 101
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AC 103
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AC 106
AC 107
AC 108
AC 109
AC 110
AC 111
AC 112
AC 113
AC 114
AC 115
AC 116
AC 117
AC 118-

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	SUBROUTINE HAFACE (IFL,D1,D2)	AD	1
	DIMENSION ALOWER(40), TABLE(1), ALINIT(40), X1STEP(40), XNU(40), X	AD	2
	INUBAR(40), SAVE(40), XSTAR(40), DX(40), DELT(40)	AD	3
	IF (IFL.EQ.2) GO TO 1	AD	4
	ARG5=D1	AD	5
	TF=D2	AD	6
	NORD=1	AD	7
	NRTAB=0	AD	8
	DTP=(TF-ARG5)*.1	AD	9
	HMIN=DTP*.02	AD	10
	ARG4=DTP*.1	AD	11
	HMAX=DTP	AD	12
	RMAX=1.E-5	AD	13
	TP=ARG5	AD	14
	ALINIT(1)=0.	AD	15
	RETURN	AD	16
1	CALL INOCAL (XNU,ALINIT,-1.,ARG5,NTAB)	AD	17
	NTAB=1	AD	18
	SENS=0.	AD	19
	GO TO 36	AD	20
2	SENSR=0.	AD	21
3	IF (TF-ARG5) 44,4,4	AD	22
4	DO 5 I=1,NORD	AD	23
	ALOWER(I)=ALINIT(I)	AD	24
	SAVE(I)=ALINIT(I)	AD	25
5	XNUBAR(I)=ALINIT(I)	AD	26
	ARG7=ARG4/2.0	AD	27
	ARG8=ARG7/2.0	AD	28
	ARG6=ARG4	AD	29
	SW3=-1.	AD	30
	ARG9=ARG5	AD	31
	ARG10=ARG6	AD	32
	ARG11=ARG7	AD	33
6	CALL INOCAL (XSTAR,XNUBAR,0.0,ARG9,NTAB)	AD	34
	DO 7 I=1,NORD	AD	35
	DX(I)=XSTAR(I)*ARG10	AD	36
7	XNUBAR(I)=XNUBAR(I)+(DX(I)/2.0)	AD	37
	ARG9=ARG9+ARG11	AD	38
	CALL INOCAL (XSTAR,XNUBAR,0.0,ARG9,NTAB)	AD	39
	DO 8 I=1,NORD	AD	40
	TEMP=XSTAR(I)*ARG10	AD	41
	DX(I)=DX(I)+(TEMP*2.0)	AD	42

8	XNUBAR(I)=SAVE(I)+(TEMP/2.0)	AD	43
	CALL INOCAL (XSTAR,XNUBAR,0.0,ARG9,NTAB)	AD	44
	DO 9 I=1,NORD	AD	45
	TEMP=XSTAR(I)*ARG10	AD	46
	DX(I)=DX(I)+(TEMP*2.0)	AD	47
9	XNUBAR(I)=TEMP+SAVE(I)	AD	48
	ARG9=ARG9+ARG11	AD	49
	CALL INOCAL (XSTAR,XNUBAR,0.0,ARG9,NTAB)	AD	50
	DO 10 I=1,NORD	AD	51
10	XSTAR(I)=(((XSTAR(I)*ARG10)+DX(I))/6.0)+SAVE(I)	AD	52
	IF (SW3) 11,13,15	AD	53
11	SW3=0.0	AD	54
	ARG9=ARG5	AD	55
	ARG10=ARG7	AD	56
	ARG11=ARG8	AD	57
	DO 12 I=1,NORD	AD	58
	XNUBAR(I)=SAVE(I)	AD	59
12	X1STEP(I)=XSTAR(I)	AD	60
	GO TO 6	AD	61
13	SW3=1.0	AD	62
	ARG9=ARG5+ARG7	AD	63
	DO 14 I=1,NORD	AD	64
	XNUBAR(I)=XSTAR(I)	AD	65
14	SAVE(I)=XNUBAR(I)	AD	66
	GO TO 6	AD	67
15	DO 16 I=1,NORD	AD	68
	DELT(I)=(XSTAR(I)-X1STEP(I))/15.0	AD	69
	XNU(I)=XSTAR(I)+DELT(I)	AD	70
16	ALOWER(I)=XNU(I)	AD	71
	QMAX=0.	AD	72
	DO 25 I=1,NORD	AD	73
	IF (ABS(XNU(I))-1.0) 17,18,18	AD	74
17	QUO=ABS(DELT(I))	AD	75
	GO TO 19	AD	76
18	QUO=ABS(DELT(I)/XNU(I))	AD	77
19	IF (QMAX-QUO) 20,20,21	AD	78
20	QMAX=QUO	AD	79
21	IF (RMAX-QUO) 22,22,25	AD	80
22	IF (SENS) 24,23,24	AD	81
23	ARG4=ARG4/2.0	AD	82
	IF (ARG4-HMIN) 43,43,2	AD	83
24	QMAX=RMAX	AD	84
25	CONTINUE	AD	85

	DO 26 I=1,NORD	AD 86
26	ALINIT(I)=ALOWER(I)	AD 87
	ARG5=ARG5+ARG4	AD 88
	IF (TP-ARG5) 31,31,27	AD 89
27	IF (SENSR) 28,40,28	AD 90
28	IF (TABLE(NTAB)+DTP-TP) 30,30,29	AD 91
29	TP=TABLE(NTAB)+DTP	AD 92
30	GO TO 32	AD 93
31	TP=TP+DTP	AD 94
32	CALL INOCAL (XSTAR,XNU,0.0,ARG9,NTAB)	AD 95
	SUB=1.0	AD 96
	CALL INOCAL (XSTAR,XNU,SUB,ARG9,NTAB)	AD 97
	IF (SUB-15.0) 40,44,40	AD 98
33	ARG4=HMAX	AD 99
34	IF (SENSR) 35,36,35	AD 100
35	NTAB=NTAB+1	AD 101
36	IF (NTAB-NRTAB) 37,37,2	AD 102
37	IF (TABLE(NTAB)-ARG5-ARG4) 38,39,2	AD 103
38	ARG4=TABLE(NTAB)-ARG5	AD 104
39	SENSR=1.	AD 105
	GO TO 3	AD 106
40	IF (QMAX) 33,33,41	AD 107
41	ARG4=SQRT(SQRT(RMAX/QMAX))*ARG4	AD 108
	IF (HMAX-ARG4) 33,42,42	AD 109
42	SENS=0.	AD 110
	GO TO 34	AD 111
43	ARG4=HMIN	AD 112
	SENS=1.	AD 113
	GO TO 3	AD 114
44	RETURN	AD 115
	END	AD 116-

	SUBROUTINE DTLNEQ (N,A,C,X,DET)	AE	1
	DIMENSION A(20,20), C(20), X(20), AL(20,20), CL(20), M(20)	AE	2
	DET=0.0	AE	3
	DO 2 I=1,N	AE	4
	CL(I)=C(I)	AE	5
	DO 1 J=1,N	AE	6
1	AL(I,J)=A(I,J)	AE	7
2	CONTINUE	AE	8
	IR=0	AE	9
	PRD=1.0	AE	10
	ALT=1.0	AE	11
	DO 15 J=1,N	AE	12
	ALTA=-ALT	AE	13
	BIG=0.0	AE	14
	DO 8 I=1,N	AE	15
	IRHO=1	AE	16
	IF (IR) 21,6,4	AE	17
3	IRHO=IRHO+1	AE	18
4	IF (I-M(IRHO)) 5,8,5	AE	19
5	IF (IR-IRHO) 21,6,3	AE	20
6	ALTA=-ALTA	AE	21
	V=ABS(AL(I,J))	AE	22
	IF (V-BIG) 8,8,7	AE	23
7	BIG=V	AE	24
	ALT=ALTA	AE	25
	M(IR+1)=I	AE	26
8	CONTINUE	AE	27
	IF (BIG) 21,21,9	AE	28
9	I=M(IR+1)	AE	29
	PRD=PRD*AL(I,J)	AE	30
	CL(I)=CL(I)/AL(I,J)	AE	31
	IF (J-N) 10,16,21	AE	32
10	L=J+1	AE	33
	DO 11 K=L,N	AE	34
11	AL(I,K)=AL(I,K)/AL(I,J)	AE	35
	IR=IR+1	AE	36
	DO 14 IU=1,N	AE	37
	DO 12 IRHO=1,IR	AE	38
	IF (IU-M(IRHO)) 12,14,12	AE	39
12	CONTINUE	AE	40
	DO 13 K=L,N	AE	41
13	AL(IU,K)=AL(IU,K)-AL(IU,J)*AL(I,K)	AE	42

	CL(IU)=CL(IU)-AL(IU,J)*CL(I)	AE	43
14	CONTINUE	AE	44
15	CONTINUE	AE	45
	GO TO 21	AE	46
16	DET=ALT*PRD	AE	47
	I=M(N)	AE	48
	X(N)=CL(I)	AE	49
17	IF (J-1) 20,21,18	AE	50
18	L=J	AE	51
	J=J-1	AE	52
	I=M(J)	AE	53
	X(J)=CL(I)	AE	54
	DO 19 K=L,N	AE	55
19	X(J)=X(J)-AL(I,K)*X(K)	AE	56
	GO TO 17	AE	57
20	DET=0.0	AE	58
21	RETURN	AE	59
	END	AE	60-

	SUBROUTINE HTP (ITSW)	AF	1
		AF	2
C		AF	3
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	AF	4
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	AF	5
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	AF	6
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(15),VNT(17),VNU(1	AF	7
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	AF	8
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	AF	9
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	AF	10
	COMMON /RAD/ XNN(7,100)	AF	11
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	AF	12
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	AF	13
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	AF	14
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	AF	15
	1HVM(20),FHVP(20)	AF	16
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	AF	17
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	AF	18
	DIMENSION NICN(100)	AF	19
	DIMENSION PRES(100)	AF	20
	DIMENSION HH(100)	AF	21
	ALP(1)=6.9375	AF	22
	ALP(2)=5.5	AF	23
	ALP(3)=1.4375	AF	24
	ITSW=2	AF	25
	ION=1	AF	26
	IS=3	AF	27
	N=6	AF	28
	W26(1)=0.54862E-03	AF	29
	W26(2)=14.007451	AF	30
	W26(3)=15.999451	AF	31
	KAT(1)=0	AF	32
	KAT(2)=7	AF	33
	KAT(3)=8	AF	34
	DEGI(1)=-1.0	AF	35
	DEGI(2)=1.0	AF	36
	DEGI(3)=1.0	AF	37
	DO 1 J=1,6	AF	38
1	KODE(J)=2	AF	39
	DO 2 J=1,6	AF	40
	DO 2 K=1,5	AF	41
	ALPT(J,K)=0.0	AF	42

2	JAT(J,K)=0	AF	43
	ALPT(1,1)=1.0	AF	44
	ALPT(2,1)=2.0	AF	45
	ALPT(2,2)=2.0	AF	46
	JAT(2,2)=7	AF	47
	ALPT(3,1)=1.0	AF	48
	JAT(3,1)=8	AF	49
	ALPT(4,1)=1.0	AF	50
	ALPT(4,2)=1.0	AF	51
	JAT(4,2)=8	AF	52
	ALPT(5,1)=1.0	AF	53
	JAT(5,1)=7	AF	54
	ALPT(6,1)=1.0	AF	55
	ALPT(6,2)=1.0	AF	56
	JAT(6,2)=7	AF	57
	RA(1,1)=0.0	AF	58
	RC(1,1)=3.9483	AF	59
	RD(1,1)=6.46872E-04	AF	60
	RE(1,1)=-1.57124E+06	AF	61
	TU(1,1)=5000.	AF	62
	RA(1,2)=0.0	AF	63
	RC(1,2)=7.71015	AF	64
	RD(1,2)=1.42221E-04	AF	65
	RE(1,2)=-3.59273E+07	AF	66
	TU(1,2)=24000.	AF	67
	RC1(1,1)=6.4483	AF	68
	RD1(1,1)=6.46871E-04	AF	69
	RE1(1,1)=-1.57124E+06	AF	70
	TU2(1,1)=5000.	AF	71
	RC1(1,2)=10.2102	AF	72
	RD1(1,2)=1.42221E-04	AF	73
	RE1(1,2)=-3.59274E+07	AF	74
	TU2(1,2)=24000.	AF	75
	RA(2,1)=0.0	AF	76
	RC(2,1)=24.9173	AF	77
	RD(2,1)=1.08123E-03	AF	78
	RE(2,1)=-2.21576E+06	AF	79
	TU(2,1)=5000.	AF	80
	RA(2,2)=0.0	AF	81
	RC(2,2)=30.6229	AF	82
	RD(2,2)=3.01129E-04	AF	83
	RE(2,2)=-5.19808E+07	AF	84
	TU(2,2)=24000.	AF	85

RC1(2,1)=28.2374	AF 86
RD1(2,1)=1.32899E-03	AF 87
RE1(2,1)=-2.1492E+06	AF 88
TU2(2,1)=4000.	AF 89
RC1(2,2)=33.5174	AF 90
RD1(2,2)=4.39119E-04	AF 91
RE1(2,2)=-3.14737E+07	AF 92
TU2(2,2)=24000.	AF 93
RA(3,1)=3.73033E+05	AF 94
RC(3,1)=20.0611	AF 95
RD(3,1)=6.47307E-04	AF 96
RE(3,1)=-1.57026E+06	AF 97
TU(3,1)=5000.	AF 98
RA(3,2)=3.73033E+05	AF 99
RC(3,2)=23.5272	AF 100
RD(3,2)=1.7478E-04	AF 101
RE(3,2)=-3.23627E+07	AF 102
TU(3,2)=24000.	AF 103
RC1(3,1)=22.7653	AF 104
RD1(3,1)=5.88991E-04	AF 105
RE1(3,1)=-1.72548E+06	AF 106
TU2(3,1)=6000.	AF 107
RC1(3,2)=26.3126	AF 108
RD1(3,2)=1.93706E-04	AF 109
RE1(3,2)=-5.03986E+07	AF 110
TU2(3,2)=24000.	AF 111
RA(4,1)=0.58985E+05	AF 112
RC(4,1)=20.8169	AF 113
RD(4,1)=0.655447E-03	AF 114
RE(4,1)=-0.162744E+07	AF 115
TU(4,1)=5000.	AF 116
RA(4,2)=0.58985E+05	AF 117
RC(4,2)=24.5103	AF 118
RD(4,2)=0.158277E-03	AF 119
RE(4,2)=-0.351471E+08	AF 120
TU(4,2)=24000.	AF 121
RC1(4,1)=23.3381	AF 122
RD1(4,1)=0.659562E-03	AF 123
RE1(4,1)=-0.155587E+07	AF 124
TU2(4,1)=5000.	AF 125
RC1(4,2)=26.8167	AF 126
RD1(4,2)=0.186999E-03	AF 127
RE1(4,2)=-0.322302E+08	AF 128

```

TU2(4,2)=24000.
RA(5,1)=4.48051E+05
RC(5,1)=20.609
RD(5,1)=6.56764E-04
RE(5,1)=-1.64226E+06
TU(5,1)=5000.
RA(5,2)=4.48051E+05
RC(5,2)=24.346
RD(5,2)=1.56145E-04
RE(5,2)=-3.5928E+07
TU(5,2)=24000.
RC1(5,1)=23.3481
RD1(5,1)=5.99657E-04
RE1(5,1)=-1.70972E+06
TU2(5,1)=6000.
RC1(5,2)=27.2144
RD1(5,2)=1.53048E-04
RE1(5,2)=-4.98219E+07
TU2(5,2)=24000.
RA(6,1)=0.1125E+06
RC(6,1)=19.8515
RD(6,1)=0.650822E-03
RE(6,1)=-0.156336E+07
TU(6,1)=5000.
RA(6,2)=0.1125E+06
RC(6,2)=23.2779
RD(6,2)=0.190986E-03
RE(6,2)=-0.331003E+08
TU(6,2)=24000.
RC1(6,1)=22.4633
RD1(6,1)=0.622485E-03
RE1(6,1)=-0.165345E+07
TU2(6,1)=6000.
RC1(6,2)=26.0356
RD1(6,2)=0.229541E-03
RE1(6,2)=-0.501696E+08
TU2(6,2)=24000.
RETURN
END

```

```

AF 129
AF 130
AF 131
AF 132
AF 133
AF 134
AF 135
AF 136
AF 137
AF 138
AF 139
AF 140
AF 141
AF 142
AF 143
AF 144
AF 145
AF 146
AF 147
AF 148
AF 149
AF 150
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AF 152
AF 153
AF 154
AF 155
AF 156
AF 157
AF 158
AF 159
AF 160
AF 161
AF 162
AF 163
AF 164
AF 165
AF 166
AF 167-

```

	SUBROUTINE TRAP1 (N,X,Y,C,ANS)	AG	1
	DIMENSION X(1), Y(1)	AG	2
	ANS=0.	AG	3
	DO 1 I=2,N	AG	4
	DX=X(I)-X(I-1)	AG	5
1	ANS=ANS+.5*DX*(Y(I)+Y(I-1))	AG	6
	ANS=C*ANS	AG	7
	RETURN	AG	8
	END	AG	9-

```
FUNCTION FLUT (A,B,C)
  XN=A/B
  R=(C/.00129)*29.
  FLUT=2.69E19*XN*R
  RETURN
END
```

```
AH  1
AH  2
AH  3
AH  4
AH  5
AH  6-
```

	SUBROUTINE INOCAL (DX,X,S,T,L)	AI	1
	DIMENSION DX(1), X(1)	AI	2
C		AI	3
C		AI	4
	COMMON /AAA/ A(6,6),A12(16,12),A22(7,7),ALP(6),ALPT(16,5),BMT(16),	AI	5
	1C(6,16),CH(16,2),CP(16),DEGI(6),H(16),JAT(16,5),JPH(16),KAT(6),KOD	AI	6
	2E(16),RA(16,2),RBO(16,2),RC(16,2),RD(16,2),RD1(16,2),RE(16,2),RE1(	AI	7
	316,2),SD(16),TB(3),TU(16,2),TU2(16,2),VN(17),VNE(16),VNT(17),VNU(1	AI	8
	46,6),W26(6),W3(16),Y(16),RF(16,2),RC1(16,2),HS,IG,IGMS,IGMSP,IGP,I	AI	9
	5ON,IS,ISP,ISPNGP,ISPNG2,N,NG,NP,PRESS,W27,RHO,WM,SYU,ISPNG	AI	10
	COMMON /RAD/ YY(100),TEE(100),FHV(20),NHV,NY,C2,IY	AI	11
	COMMON /RAD/ XNN(7,100)	AI	12
	COMMON /RAD/ NIHVC,FHVC(50),AHV(50),AHVL(20)	AI	13
	COMMON /RAD/ C1,C3,C4,FLG,C5,FLG1	AI	14
	COMMON /RAD/ YDELT,DELTD,FL1,FL2	AI	15
	COMMON /RAD/ GEE(8),EPS(8),NU(20),ND(70),FF(70),GAMP(70),WOL(20),F	AI	16
	1HVM(20),FHVP(20)	AI	17
	COMMON /CIONCL/ F(100,10),F2(100,10),HVL(70),EP,K2,K1,IFL,IYCON,IQ	AI	18
	11,WMI,BIJ(100,10),GMIN(100,10),GPLU(100,10),IAED	AI	19
	DIMENSION NICN(100)	AI	20
	DIMENSION PRES(100)	AI	21
	DIMENSION HH(100)	AI	22
	IF (S) 10,1,9	AI	24
1	SUM=0.	AI	25
	DO 5 I=K1,K2	AI	26
	J=I-K1+1	AI	27
	IF (F(IQ1,J).EQ.0.) GO TO 5	AI	28
	GO TO (2,3), IAED	AI	29
2	EP=GMIN(IQ1,J)	AI	30
	GO TO 4	AI	31
3	EP=GPLU(IQ1,J)	AI	32
4	CONTINUE	AI	33
	E=1./((T-HVL(I))*2+EP*EP)	AI	34
	E=E*1.17E-29	AI	35
	SUM=SUM+E*(F2(IQ1,J)-F2(IY,J))*FLOAT(IFL)/3.14159	AI	36
5	CONTINUE	AI	37
	IF (SUM-88.0) 6,6,7	AI	38
6	DX=1.0-EXP(SUM)	AI	39
	GO TO 8	AI	40
7	DX=1.0	AI	41
8	WMI=X	AI	42
	RETURN	AI	43
9	CONTINUE	AI	44
10	RETURN	AI	45
	END	AI	46-

```

SUBROUTINE TRAP (N,X,Y,C,ANS)
DIMENSION ANS(1), X(1), Y(1)
ANS(1)=0.
DO 1 I=2,N
DX=X(I)-X(I-1)
1  ANS(I)=ANS(I-1)+.5*DX*(Y(I)+Y(I-1))*C
RETURN
END

```

```

AJ 1
AJ 2
AJ 3
AJ 4
AJ 5
AJ 6
AJ 7
AJ 8-

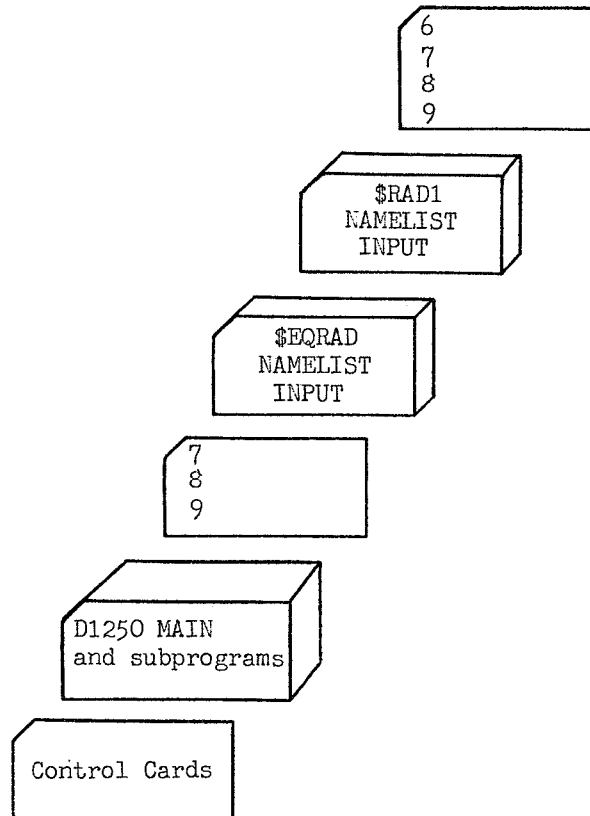
```

	SUBROUTINE MASBAL (VN,IB,C,ALP,IRHO,BD,IS,N,PR,IG)	AK	1
	DIMENSION VN(17), IB(13), C(6,16), ALP(6), A(20,20), B(20), X(20)	AK	2
	NP=N+1	AK	3
	ISP=IS+1	AK	4
	DO 2 LS=1,IS	AK	5
	B(LS)=VN(NP)*ALP(LS)	AK	6
	J=1	AK	7
	DO 2 I=1,N	AK	8
	B(LS)=B(LS)-C(LS,I)*VN(I)	AK	9
	IF (I-IB(J)) 2,1,2	AK	10
1	A(LS,J)=C(LS,I)	AK	11
	J=J+1	AK	12
2	CONTINUE	AK	13
	DO 3 J=1,ISP	AK	14
3	A(ISP,J)=0.0	AK	15
	DO 4 LS=1,IS	AK	16
4	A(LS,ISP)=-ALP(LS)	AK	17
	B(ISP)=PR	AK	18
	DO 5 I=1,IG	AK	19
5	B(ISP)=B(ISP)-VN(I)	AK	20
	J=0	AK	21
	DO 7 I=1,IS	AK	22
	IF (IB(I)-IG) 6,6,7	AK	23
6	J=J+1	AK	24
7	CONTINUE	AK	25
	DO 8 I=1,J	AK	26
8	A(ISP,I)=1.0	AK	27
	CALL DTLNEQ (ISP,A,B,X,V)	AK	28
	J=1	AK	29
	G=1.0	AK	30
	DO 13 I=1,NP	AK	31
	IF (I-IB(J)) 13,9,13	AK	32
9	V=BD*VN(I)	AK	33
	W=ABS(X(J))	AK	34
	IF (W-V) 12,12,10	AK	35
10	IF (V/W-G) 11,12,12	AK	36
11	G=V/W	AK	37
12	J=J+1	AK	38
13	CONTINUE	AK	39
	J=1	AK	40
	DO 15 I=1,NP	AK	41
	IF (I-IB(J)) 15,14,15	AK	42
14	VN(I)=VN(I)+G*X(J)	AK	43
	J=J+1	AK	44
15	CONTINUE	AK	45
	RETURN	AK	46
	END	AK	47-

USAGE

Program Information and Deck Configuration

The program D1250 was written in the FORTRAN IV language for the Control Data 6600 computer system under the Scope 3.2 operating system. The program requires a field length of 110 000 octal locations; the computing time depends primarily on the accuracy of the initial δ_0 and the number of iterations desired, KETEST. The following sketch shows the deck configuration needed for execution:



For the sample case ($U'_\infty = 15.24 \times 10^5$ cm/sec (50 000 ft/sec), and altitude of 60.96 km (200 000 ft), and KETEST = 12), the run time was 18.21 minutes. The results of a similar case are discussed in reference 3.

Input Description

The input is loaded by using the FORTRAN IV NAMELIST. The input symbols are as follows with typical values given in parentheses:

\$EQRAD

ALT altitude for AT62

AOVERB	ratio of semiminor axis to semimajor axis of an ellipse
CCI	initial computing interval for INT1 (0.05)
CII	initial linear integration step away from singular point of stagnation streamline; used in FIRST (0.05)
CIMAX	absolute value of maximum computing interval in INT1
DELTX	an increment used in ITR1 so that $\frac{f(x + DELTX) - f(x)}{DELTX}$ is a reasonable approximation to derivative of $f(x)$ (-1.E-3)
DUMBTIM	initial guess for standoff distance = $\frac{DUMBTIM}{RHO1}$ (0.78 for sphere)
EELE1	array of relative error for dependent variables used by INT1 (1.E-3)
EELE2	array of relative zero for dependent variables used by INT1 (1.E-4)
EELT	array of NT values to return to the program from INT1 at specific values (NT is computed in CONT)
EITR1	relative error criterion for ITR1 (1.E-4)
EITR2	absolute error criterion for ITR1 (1.E-4)
EMUREF	molecular weight of cold air, g/mole (28.967)
EPSR	accuracy criterion for R_1 iteration in MAIN (0.01)
EPS21	accuracy criterion used in PROPIT for RHO iteration (1.E-3)
IALT	option for atmosphere routine: = 1 call AT62 and input ALT ≠ 1 input PIN, RHOIN
IGEO	test in GEO: 1 sphere geometry 2 ellipsoid geometry 3 hyperboloid geometry

ITEXT	time history print option for INT1; if equal to 0, no printout is requested; if equal to 1, a printout is requested
ITTEST	iteration limit in PROPIT (500)
KETEST	number of iterations desired on DELTN (10)
KKKK	radiation option: 0 do not compute radiation 1 adiabatic radiation 2 nonadiabatic radiation
PEEP	coefficient in equation describing pressure variation in stagnation region (see ref. 3, eq. (36)) (-2.5 for sphere)
PIN	free-stream pressure, dyn/cm ²
QI1 QI2 QO1 QO2	} curve-fit coefficients to radiation distribution around body, used for all but the final δ_0 iteration (see discussion on p. 42)
R	gas constant, ergs/mole-°K
RB	body radius at axis of symmetry $x = 0$, cm
RHOIN	free-stream density, g/cm ³
RHON	initial guess for RHO, nondimensionalized
R1	initial guess for weighted heat flux, nondimensionalized (if value not known, use $R1 = 0$)
SSPEC	print control option for INT1
TEAN	initial guess for T' , °K

TCG accuracy criterion for iteration in RANH (0.001)

UIN free-stream velocity, cm/sec

XMAX limiting value in x-direction

\$

The input for the radiation portion of the program was supplied with the RATRAP code. Part of the data is permanent and, therefore, is not normally modified. The input is loaded by using FORTRAN IV NAMELIST. The input symbols are as follows:

\$RAD1

GEE

EPS

FHVM

FHVP

FHV

WOL

NU

ND

HVL

FF

GAMP

IS

} permanent data supplied with code for occupation number, density calculation, and line absorption coefficient

NIHVC total number of continuum spectral points

FHVC	spectral points for continuum calculation
AHV	transmission factors for continuum calculation
AHVL	transmission factors for line calculation
FL1	1 intensity calculation
	2 flux calculation
FL2	1 intensity calculation
	2 flux calculation
FLG	0 normal output
	$\neq 0$ diagnostic output
FLG1	0 intensity calculation
	$\neq 0$ flux calculation
NIC	number of y/δ points where transport evaluated
NICN	an array of NIC values of index location of y/δ points where transport is evaluated
IOPT	option in subprogram FEMP:
	1 temperatures supplied
	2 enthalpies supplied
NY	number of values of YY, PRES, TEE, and HH (maximum is 100)
TB	initial temperature estimate

A listing of the NAMELIST input data appears in the output for the sample case.

Discussion of Output

The output of program D1250 consists of printing only. The NAMELIST input EQRAD is printed from MAIN and the NAMELIST RAD1 from PROD. If PIN and RHOIN are found by the atmosphere routine, they are printed in MAIN. Also printed in MAIN

are the initial DELTA for each δ_0 iteration and the maximum x from the previous iterations. The remainder of the output is printed only during the final δ_0 iteration. The results from the integration routine are printed by CONT. The frequency of the output in CONT is controlled by a print option in INT1. If SSPEC is zero, control is returned to the program after every acceptable integration step. The distribution across the shock layer is written by PROD and the radiation results are written by RADFLUX. The output symbols are as follows:

AT62:

RHOIN ρ_∞

PIN p_∞

DELTN δ_0

X x

Stagnation-point conditions:

UO u_0

RHOO ρ_0

AO a_0

RHOOAO $\rho_0 a_0$

HO H_0

PO p_0

DWDX $\frac{d\omega}{dx}$

Shock standoff distance:

DELTD dimensional δ , cm

DELTA/RB δ/R_B

Distribution across shock layer:

ETA η

PDUM p

STAENT h

CAPH H

AUDUM u velocity gradient when PROD is called by MAIN

 u velocity when PROD is called by CONT

V v

Radiation output:

PATH LENGTH

PRESSURE

TEMPERATURE

ENTHALPY

DENSITY

DENSITY (ND)

QRYPC body and shock continuum radiation heat flux, watts/cm²

QRYPL body and shock line radiation heat flux, watts/cm²

QRYO total radiation heat flux at body, dimensionless

QRY1 total radiation heat flux at shock, dimensionless

Properties at first step off stagnation line:

X x

DELTA	δ	
W	ω	
IO(2) to IO(5)	$I_{j,0}$	(j = 2,3,4,5)
SMALRB	r_b	
Body and shock properties:		
X	x	
DELTA	δ	
W	ω	
IO(2) to IO(5)	$I_{j,0}$	(j = 2,3,4,5)
SMALRB	r_b	
I1(2) to I1(5)	$I_{j,1}$	(j = 2,3,4,5)
RBX	R_B	at any x-coordinate
THETAB	θ_b	
Q	Q	
DDELDX	$\frac{d\delta}{dx}$	
DWDX	$\frac{d\omega}{dx}$	
DIODX(2) to DIODX(5)	$\frac{dI_{j,0}}{dx}$	(j = 2,3,4,5)
DSMALRBDX	$\frac{dr_b}{dx}$	
PRATIO	$\frac{PO}{PSTAG}$	
QRATIO	ratio of heat flux at body to stagnation heat flux	

Output for Sample Case

```

$EQRAD
ALT      = 0.2E+06,
ADVERB   = 0.1E+01,
CCI      = 0.5E-02,
CII      = 0.5E-02,
CIMAX    = 0.0,
DELTX    = -0.1E-02,
DUMBTIM  = 0.78E+00,
EELE1    = 0.1E-02, 0.1E-02, 0.1E-02, 0.1E-02, 0.1E-02, 0.1E-02,
EELE2    = 0.1E-03, 0.1E-03, 0.1E-03, 0.1E-03, 0.1E-03, 0.1E-03,
EELT     = 0.1E+04, 0.2E+04, 0.3E+04,
EITR1    = 0.1E-03,
EITR2    = 0.1E-03,
EMUREF   = 0.28967E+02,
EPSR     = 0.1E-01,
EPS21    = 0.1E-02,
IALT     = 1,
IGED     = 1,
ITEXT    = 0,
ITYEST   = 500,
KETEST   = 12,
KXXX     = 1,
PEEP     = -0.25E+01,
PIN      = 0.16212E+03,
QIL      = -0.302E+01,

```



```

QI2      = 0.204E+01,
Q01      = -0.19875E+01,
Q02      = 0.125E+01,
R         = 0.8314395E+08,
RB        = 0.3048E+03,
RHOV      = 0.14E+02,
RHOIN     = 0.23773E-06,
R1        = 0.134661176E+00,
SSPEC     = 0.0,
TEAN      = 0.5E+04,
TCG       = 0.1E-02,
UIN       = 0.1524E+07,
XMAX      = 0.15708E+01,
$END

AT62      RHOIN 2.71626956E-07      PIN 1.97961862E+02
DELTN 4.43919683E-02      X 0.

```

\$RAD1

$$\text{GEE} = 0.4\text{E}+01, 0.1\text{E}+02, 0.6\text{E}+01, 0.18\text{E}+02, 0.54\text{E}+02, 0.9\text{E}+02, 0.9\text{E}+01, 0.0,$$

EPS = 0.0, 0.2384E+01, 0.3576E+01, 0.10452E+02, 0.11877E+02, 0.13002E+02, 0.0, 0.0,

FHWM = 0.6E+00, 0.85E+00, 0.97E+00, 0.12E+01, 0.14E+01, 0.162E+01,
0.24E+01, 0.34E+01, 0.62E+01, 0.8E+01, 0.86E+01, 0.9E+01,
0.97E+01, 0.108E+02, 0.12E+02, 0.128E+02, 0.134E+02, 0.138E+02,
0.0, 0.0,

FWHP = 0.8E+00, 0.95E+00, 0.12E+01, 0.14E+01, 0.155E+01, 0.24E+01,
0.33E+01, 0.4E+01, 0.8E+01, 0.86E+01, 0.9E+01, 0.97E+01,
0.108E+02, 0.12E+02, 0.128E+02, 0.134E+02, 0.138E+02,
0.145E+02, 0.0, 0.0,

$$= 0.69E+00, 0.89E+00, 0.105E+01, 0.129E+01, 0.146E+01, 0.185E+01, 0.285E+01, 0.37E+01, 0.711E+01, 0.830E+01, 0.8781E+01, 0.94E+01, 0.104E+02, 0.115E+02, 0.1241E+02, 0.1304E+02, 0.1358E+02, 0.142E+02, 0.0, 0.0,$$

WOL = 0.2E-01, 0.3E-01, 0.5E-01, 0.45E-01, 0.8E-01, 0.1E+00,
0.25E-01, 0.17E+00, 0.18E+01, 0.6E+00, 0.4E+00, 0.8E-01,
0.5E-01, 0.5E-01, 0.5E-01, 0.75E-01, 0.8E-01, 0.1E+00, 0.0,
0.0,

NU = 4, 2, 4, 4, 2, 4, 3, 4, 1, 1, 3, 9, 10, 3, 3, 3, 4, 0, 0

[illegible]

HVL	=	0.657E+00,	0.674E+00,	0.69E+00,	0.71E+00,	0.877E+00,	0.911E+00,
		0.998E+00,	0.1033E+01,	0.1119E+01,	0.117E+01,	0.1225E+01,	
		0.1268E+01,	0.1319E+01,	0.1368E+01,	0.143E+01,	0.1509E+01,	
		0.1663E+01,	0.1836E+01,	0.1919E+01,	0.2075E+01,	0.2571E+01,	
		0.2925E+01,	0.3107E+01,	0.3466E+01,	0.3541E+01,	0.3849E+01,	
		0.3926E+01,	0.7111E+01,	0.8302E+01,	0.8781E+01,	0.9301E+01,	
		0.9374E+01,	0.946E+01,	0.9973E+01,	0.10102E+02,	0.10332E+02,	
		0.10418E+02,	0.10493E+02,	0.10585E+02,	0.10619E+02,	0.10682E+02,	
		0.10757E+02,	0.10927E+02,	0.112E+02,	0.11293E+02,	0.1131E+02,	
		0.11424E+02,	0.11609E+02,	0.11776E+02,	0.11874E+02,	0.11948E+02,	
		0.12E+02,	0.12316E+02,	0.12414E+02,	0.12511E+02,	0.12877E+02,	
		0.13004E+02,	0.1319E+02,	0.13508E+02,	0.13543E+02,	0.13677E+02,	
		0.13993E+02,	0.1416E+02,	0.14257E+02,	0.14332E+02,	0.0,	0.0,

AHVL	=	0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,	0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01, 0.31416E+01,
FL1	=	0.2E+01,	
FL2	=	0.2E+01,	
FLG	=	0.0,	
FLG1	=	0.1E+01,	
NIC	=	2,	
NICV	=	1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,	0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
IOPT	=	2,	
TB	=	0.15E+05, 0.0, 0.0,	
NY	=	11,	
\$END			

DELTA 4.08873392E-02	X	3.95000000E-01
DELTA 3.91350247E-02	X	4.25000000E-01
DELTA 3.82588674E-02	X	4.65000000E-01
RHO IS SMALLER THAN ALLOWED		
DELTA 3.86969461E-02	X	4.85000000E-01
DELTA 3.84779068E-02	X	4.85000000E-01
DELTA 3.83683871E-02	X	5.25000000E-01
DELTA 3.83136273E-02	X	5.65000000E-01
RHO IS SMALLER THAN ALLOWED		
DELTA 3.83410072E-02	X	5.05000000E-01
H IS ZERO OR NEGATIVE		
DELTA 3.83546971E-02	X	5.45000000E-01
DELTA 3.83478522E-02	X	5.65000000E-01
RHO IS SMALLER THAN ALLOWED		
DELTA 3.83512747E-02	X	5.45000000E-01

STAGNATION POINT CONDITIONS UD 0. AD 2.25838184E-01
 RHOAO 1.06749780E+01 RHOD 4.72682601E+01
 SHOCK STAND-OFF DISTANCE DELTD 1.16894685E+01 DELTA/RB 3.83512747E-02
 DWDX-1.01135076E+00

DISTRIBUTION ACROSS SHOCK LAYER							
ETA	PDUM	STAENT	CAPH	AUDUM	V		
3.	9.64327061E-01	1.76326038E-01	1.76326038E-01	2.25838184E-01	0.		
1.00000000E-01	9.64087950E-01	2.24796404E-01	2.24796404E-01	3.43066632E-01	-8.94833413E-03		
2.00000000E-01	9.63370615E-01	2.68157802E-01	2.68301725E-01	4.48103235E-01	-1.69660349E-02		
3.00000000E-01	9.62175058E-01	3.07177428E-01	3.07470033E-01	5.42755920E-01	-2.41911058E-02		
4.00000000E-01	9.60501278E-01	3.42476211E-01	3.42948548E-01	6.28491991E-01	-3.07355497E-02		
5.00000000E-01	9.58349275E-01	3.74562082E-01	3.75235205E-01	7.06514734E-01	-3.66912165E-02		
6.00000000E-01	9.55719048E-01	4.03854557E-01	4.04742199E-01	7.77820247E-01	-4.21341407E-02		
7.00000000E-01	9.52610599E-01	4.30703167E-01	4.31813682E-01	8.43240193E-01	-4.71278051E-02		
8.00000000E-01	9.49023927E-01	4.55401473E-01	4.56739243E-01	9.03474383E-01	-5.17256281E-02		
9.00000000E-01	9.44959032E-01	4.78197829E-01	4.79764311E-01	9.59115913E-01	-5.59728821E-02		
1.00000000E+00	9.40415914E-01	4.99303768E-01	5.01098264E-01	1.01067076E+00	-5.99081894E-02		

PATH LENGTH				DENSITY(ND)			
(Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)			
0.	6.00414E-01	8.16031E+03	9.77400E+03	1.32420E-05	4.87506E+01		
1.00000E-01	6.00265E-01	1.04720E+04	1.24608E+04	9.63634E-06	3.54764E+01		
2.00000E-01	5.99818E-01	1.16447E+04	1.48644E+04	8.12868E-06	2.99259E+01		
3.00000E-01	5.99074E-01	1.23573E+04	1.70273E+04	7.21803E-06	2.65733E+01		
4.00000E-01	5.98032E-01	1.28722E+04	1.89839E+04	6.57105E-06	2.41914E+01		
5.00000E-01	5.96692E-01	1.32780E+04	2.07625E+04	6.07585E-06	2.23684E+01		
6.00000E-01	5.95054E-01	1.36157E+04	2.23862E+04	5.67859E-06	2.09058E+01		
7.00000E-01	5.93119E-01	1.39065E+04	2.38745E+04	5.35018E-06	1.96968E+01		
8.00000E-01	5.90886E-01	1.41636E+04	2.52435E+04	5.07197E-06	1.86726E+01		
9.00000E-01	5.88355E-01	1.43952E+04	2.65072E+04	4.83188E-06	1.77887E+01		
1.00000E+00	5.85526E-01	1.46079E+04	2.76771E+04	4.62057E-06	1.70107E+01		

QRYPC 3.00159291E+03 6.59064604E+03 QRYPL 2.07189299E+03 4.45971229E+03 QRYD-5.27689789E-02 QRY1 1.14934019E-01

PROPERTIES AT FIRST STEP OFF STAGNATION LINE
 X 5.00000000D-03 DELTA 3.83509801D-02 W 1.56573960D+00 ID(2) 5.33748901D-02 ID(3) 9.64387332D-01
 IG(4) 0. IG(5) 9.41141692D-03 SNALRB 0.

BODY AND SHOCK PROPERTIES
 X 5.0000000D-03 DELTA 3.83509801D-02 IO(3) 9.64387332D-01
 IO(4) 0. IO(5) 9.41141692D-03 IO(6) 8.43508003E-02 IO(7) 9.40818045E-01
 IO(8) 5.05327013E-03 IO(9) 4.22680396E-02 IO(10) 1.56577633E+00 IO(11) 1.00000000E+00
 ODELDX-5.85044012E-05 DMDX-1.00948451E+00 DIODX(2) 1.07048948E+01 DIODX(3) 1.20878701E-02 DIODX(4) 0.
 DIODX(5) 1.89715195E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER ETA

	PDM	STAENT	CAPH	AUDM	V
0.	9.64327061E-01	1.76326038E-01	1.76326675E-01	1.12919092E-03	0.
1.	9.64087917E-01	2.24795068E-01	2.24836574E-01	1.71532177E-03	-8.94819925E-03
2.	9.63370020E-01	2.68155100E-01	2.68301529E-01	2.24049604E-03	-1.69658016E-02
3.	9.62173373E-01	3.07173359E-01	3.07469638E-01	2.71375279E-03	-2.41908021E-02
4.	9.60497973E-01	3.42470791E-01	3.42948055E-01	3.14242806E-03	-3.07351971E-02
5.	9.58343822E-01	3.74555340E-01	3.75234688E-01	3.53253797E-03	-3.66908317E-02
6.	9.55710920E-01	4.03846529E-01	4.04741717E-01	3.88906272E-03	-4.21337368E-02
7.	9.52599266E-01	4.30693895E-01	4.31813278E-01	4.21616044E-03	-4.71273923E-02
8.	9.49008860E-01	4.55390999E-01	4.56738951E-01	4.51733001E-03	-5.17252143E-02
9.	9.44939703E-01	4.78186198E-01	4.79764156E-01	4.79553679E-03	-5.59724737E-02
1.	9.40391794E-01	4.99291024E-01	5.01098264E-01	5.05331055E-03	-5.99077912E-02

PATH LENGTH (Y/DELTA)

	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	6.00414E-01	8.16031E+03	9.77400E+03	1.32420E-05
1.	6.00285E-01	1.04719E+04	1.24607E+04	9.63640E-06
2.	5.99818E-01	1.16446E+04	1.48642E+04	8.12875E-06
3.	5.99073E-01	1.23573E+04	1.70271E+04	7.21810E-06
4.	5.98030E-01	1.28721E+04	1.89836E+04	6.57112E-06
5.	5.96688E-01	1.32779E+04	2.07621E+04	6.07591E-06
6.	5.95049E-01	1.36156E+04	2.23858E+04	5.67864E-06
7.	5.93112E-01	1.39064E+04	2.38740E+04	5.35022E-06
8.	5.90876E-01	1.41635E+04	2.52430E+04	5.07200E-06
9.	5.88343E-01	1.43951E+04	2.65065E+04	4.83189E-06
1.	5.85511E-01	1.46078E+04	2.76764E+04	4.62057E-06

QRYPC 3.00140163E+03 6.59012703E+03 QRYPL 2.06121076E+03 4.46000428E+03 QRYQ-5.26558842E-02 QRYV 1.14931658E-01

PRATIO 1.00000000E+00 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 2.500000000-02 DELTA 3.83478404D-02 W 1.54555863D+00 IO(2) 2.67600596D-01 IO(3) 9.65117515D-01
 IO(4) 0. IO(5) 4.74085075D-02 SMALRB 0. SMALRB 0. IO(2) 4.20975327E-01 IO(3) 9.50432569E-01
 II(4)-2.52152719E-02 II(5) 2.10950506E-01 RBX 1.00000000E+00 THETAB 1.54579632E+00 Q 1.00000000E+00
 DDELDX-2.46807887E-04 DWDX-1.00756351E+00 DIODX(2) 1.0733990E+01 DIODX(3) 6.11161198E-02 DIODX(4) 0.
 DIODX(5) 1.91043466E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUH	STAENT	CAPH	AUDUM	V
0.	9.63593765E-01	1.77145233E-01	1.77161442E-01	5.69369531E-03	0.
1.00000000E-01	9.63361238E-01	2.25282474E-01	2.25359157E-01	8.59907922E-03	-8.91193718E-03
2.00000000E-01	9.62651972E-01	2.68394431E-01	2.68600144E-01	1.12056689E-02	-1.69073567E-02
3.00000000E-01	9.61465966E-01	3.07228838E-01	3.07611643E-01	1.35573028E-02	-2.41207283E-02
4.00000000E-01	9.59803220E-01	3.42392119E-01	3.42985263E-01	1.56896434E-02	-3.08614426E-02
5.00000000E-01	9.57663735E-01	3.74381258E-01	3.75207192E-01	1.76319985E-02	-3.66193973E-02
6.00000000E-01	9.55047511E-01	4.03607421E-01	4.04680676E-01	1.94086757E-02	-4.20691544E-02
7.00000000E-01	9.51954547E-01	4.30413706E-01	4.31742984E-01	2.10400060E-02	-4.70730759E-02
8.00000000E-01	9.48384843E-01	4.55088670E-01	4.56678363E-01	2.25431243E-02	-5.16837216E-02
9.00000000E-01	9.44338400E-01	4.77876750E-01	4.79728095E-01	2.39325740E-02	-5.59457018E-02
1.00000000E+00	9.39815218E-01	4.98986387E-01	5.01098264E-01	2.52207792E-02	-5.98971256E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	(ND)
0.	5.99957E-01	8.19355E+03	9.81941E+03	1.31560E-05	4.84340E+01
1.00000E-01	5.99812E-01	1.04889E+04	1.24877E+04	9.60705E-06	3.53685E+01
2.00000E-01	5.99371E-01	1.16493E+04	1.48775E+04	8.11649E-06	2.98810E+01
3.00000E-01	5.98632E-01	1.23577E+04	1.70301E+04	7.21192E-06	2.65508E+01
4.00000E-01	5.97597E-01	1.28705E+04	1.89793E+04	6.56786E-06	2.41797E+01
5.00000E-01	5.96265E-01	1.32752E+04	2.07525E+04	6.07422E-06	2.23624E+01
6.00000E-01	5.94636E-01	1.36123E+04	2.23725E+04	5.67781E-06	2.09030E+01
7.00000E-01	5.92710E-01	1.39028E+04	2.38584E+04	5.34985E-06	1.96956E+01
8.00000E-01	5.90488E-01	1.41598E+04	2.52262E+04	5.07186E-06	1.86722E+01
9.00000E-01	5.87968E-01	1.43913E+04	2.64894E+04	4.83185E-06	1.77886E+01
1.00000E+00	5.85152E-01	1.46041E+04	2.76595E+04	4.62052E-06	1.70105E+01

QRYPC 2.99787128E+03 6.57564746E+03 QRYPL 2.06196097E+03 4.45251997E+03 QRYO-5.26269682E-02 QRYV 1.14703213E-01
 PRATIO 9.99239578E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.5000000D-02 DELTA 3.8341663D-02
 IO(4) 0. IO(5) 8.59501166D-02
 II(4)-4.52699809E-02 II(5) 3.78908456E-01
 DDEL0X-3.53862846E-04 DWDX-1.00270656E+00
 DI0DX(5) 1.94322511E+00 DSMALRDX 0.

W 1.52545553D+00
 SMALRB 0.
 RAX 1.00000000E+00
 DI0DX(2) 1.08047489E+01
 DI0DX(3) 1.11739121E-01
 DI0DX(4) 0.

IO(3) 9.66843149D-01
 II(3) 9.72735574E-01
 Q 1.00000000E+00

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	9.61857293E-01	1.77898958E-01	1.77952433E-01	1.03416676E-02	0.
1.0000000E-01	9.61640737E-01	2.25674916E-01	2.25834739E-01	1.55223575E-02	-8.87105716E-03
2.0000000E-01	9.60952765E-01	2.68506015E-01	2.68851367E-01	2.01765996E-02	-1.68406614E-02
3.0000000E-01	9.59793378E-01	3.07121961E-01	3.07708122E-01	2.43807583E-02	-2.40395737E-02
4.0000000E-01	9.58162575E-01	3.42115648E-01	3.42980584E-01	2.81971097E-02	-3.05744313E-02
5.0000000E-01	9.56060356E-01	3.73973784E-01	3.75142831E-01	3.16769471E-02	-3.65330657E-02
6.0000000E-01	9.53486722E-01	4.03099639E-01	4.04588868E-01	3.48629003E-02	-4.19884729E-02
7.0000000E-01	9.50441672E-01	4.29830184E-01	4.316448837E-01	3.77906902E-02	-4.70018190E-02
8.0000000E-01	9.46925207E-01	4.54449176E-01	4.56601472E-01	4.04904740E-02	-5.16247432E-02
9.0000000E-01	9.42937326E-01	4.77197265E-01	4.79683713E-01	4.29878880E-02	-5.59011432E-02
1.0000000E+00	9.38478030E-01	4.98279876E-01	5.01098264E-01	4.53048640E-02	-5.98685737E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	(ND)
0.	5.98876E-01	8.22459E+03	9.86119E+03	1.30627E-05	4.80905E+01
1.00000E-01	5.98741E-01	1.05020E+04	1.25095E+04	9.57262E-06	3.52418E+01
2.00000E-01	5.98313E-01	1.16506E+04	1.48837E+04	8.09973E-06	2.98193E+01
3.00000E-01	5.97591E-01	1.23548E+04	1.70242E+04	7.20205E-06	2.65145E+01
4.00000E-01	5.96575E-01	1.28655E+04	1.89640E+04	6.56163E-06	2.41568E+01
5.00000E-01	5.95267E-01	1.32690E+04	2.07299E+04	6.07018E-06	2.23475E+01
6.00000E-01	5.93664E-01	1.36053E+04	2.23444E+04	5.67519E-06	2.08933E+01
7.00000E-01	5.91768E-01	1.38952E+04	2.38261E+04	5.34818E-06	1.96894E+01
8.00000E-01	5.89579E-01	1.41517E+04	2.51908E+04	5.07087E-06	1.86685E+01
9.00000E-01	5.87096E-01	1.43829E+04	2.64517E+04	4.83137E-06	1.77868E+01
1.00000E+00	5.84319E-01	1.45954E+04	2.76204E+04	4.62041E-06	1.70101E+01

QRYPC 2.98617631E+03 6.54094413E+03 QRYPL 2.06120834E+03 4.42816779E+03 QRYO-5.24975014E-02 QRY1 1.140888981E-01

PRATIO 9.97438869E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 6.50000000D-02 DELTA 3.83342394D-02 W 1.50543498D+00 IO(2) 6.99479998D-01 IO(3) 9.69593650D-01
 IO(4) 0. IO(5) 1.24977254D-01 SMALRB 0. SMALRB 0. IO(2) 1.08964146E+00 IO(3) 1.00753800E+00
 I1(4)-6.51795024E-02 I1(5) 5.46017445E-01 RBX 1.00000000E+00 THETAB 1.50579632E+00 I1(3) 1.00753800E+00
 DDELDX-3.75199063E-04 DMWX-9.99175063E-01 DIODX(2) 1.08445144E+01 DIODX(3) 1.63528336E-01 DIODX(4) 0.
 DIODX(5) 1.95979713E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUW	STAENT	CAPH	AUDUM	V
0.	9.59052058E-01	1.78557969E-01	1.78671663E-01	1.50793600E-02	0.
1.00000000E-01	9.58861846E-01	2.25953477E-01	2.26245289E-01	2.48883483E-02	-8.82597735E-03
2.00000000E-01	9.58210342E-01	2.68478832E-01	2.69044355E-01	2.91537594E-02	-1.67661665E-02
3.00000000E-01	9.57097547E-01	3.06847653E-01	3.07753288E-01	3.51821844E-02	-2.39475441E-02
4.00000000E-01	9.55523459E-01	3.41640688E-01	3.42931668E-01	4.06607704E-02	-3.04739244E-02
5.00000000E-01	9.53488081E-01	3.73335352E-01	3.75041446E-01	4.56614607E-02	-3.64310103E-02
6.00000000E-01	9.50991410E-01	4.02327722E-01	4.04467354E-01	5.02441723E-02	-4.18901779E-02
7.00000000E-01	9.48033448E-01	4.28949146E-01	4.31532383E-01	5.44592075E-02	-4.69113500E-02
8.00000000E-01	9.44614193E-01	4.53478945E-01	4.56509709E-01	5.83491083E-02	-5.15452049E-02
9.00000000E-01	9.40733648E-01	4.76154234E-01	4.79631909E-01	6.19500976E-02	-5.58348931E-02
1.00000000E+00	9.36391810E-01	4.97177603E-01	5.01098264E-01	6.52932098E-02	-5.98173846E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(V/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	5.97129E-01	8.25194E+03	9.89772E+03	1.29642E-05	4.77280E+01
1.00000E-01	5.97011E-01	1.05105E+04	1.25249E+04	9.53329E-06	3.50970E+01
2.00000E-01	5.96605E-01	1.16484E+04	1.48822E+04	8.07824E-06	2.97402E+01
3.00000E-01	5.95912E-01	1.23485E+04	1.70090E+04	7.18815E-06	2.64633E+01
4.00000E-01	5.94932E-01	1.28571E+04	1.89376E+04	6.55209E-06	2.41216E+01
5.00000E-01	5.93665E-01	1.32591E+04	2.06945E+04	6.06348E-06	2.23228E+01
6.00000E-01	5.92111E-01	1.35944E+04	2.23016E+04	5.67049E-06	2.08760E+01
7.00000E-01	5.90269E-01	1.38835E+04	2.37773E+04	5.34499E-06	1.96777E+01
8.00000E-01	5.88140E-01	1.41394E+04	2.51370E+04	5.06886E-06	1.86611E+01
9.00000E-01	5.85724E-01	1.43700E+04	2.63939E+04	4.83035E-06	1.77830E+01
1.00000E+00	5.83020E-01	1.45820E+04	2.75593E+04	4.62024E-06	1.70095E+01

QRYPC 2.96624698E+03 6.48620144E+03 QRYPL 2.04162353E+03 4.39567654E+03 QRYD-5.20865176E-02 QRY1 1.13181666E-01

PRATIO 9.94529861E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 8.50000000D-02 DELTA 3.83270261D-02 W 1.48547001D+00 IO(2) 9.16395790D-01 IO(3) 9.73384243D-01
 IO(4) 0. IO(5) 1.64149678D-01 SMALRB 0. SMALRB 0. IO(2) 9.16395790D-01 IO(3) 9.73384243D-01
 II(4)-8.49332879D-02 II(5) 7.12403081E-01 RBX 1.00000000E+00 THETAB 1.48579633E+00 II(2) 1.42168339E+00 II(3) 1.05469704E+00
 DDELDX-3.38818567E-04 DMDX-9.97283485E-01 DIODX(2) 1.08453938E+01 DIODX(3) 2.15579969E-01 DIODX(4) 0.
 DIODX(5) 1.95657445E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDM	STAENT	CAPH	AUDUM	V
0.	9.55173380E-01	1.78927749E-01	1.79125307E-01	1.98775603E-02	0.
1.00000000E-01	9.55020129E-01	2.25992278E-01	2.26465465E-01	2.94825035E-02	-8.78381658E-03
2.00000000E-01	9.54420745E-01	2.68237165E-01	2.69103609E-01	3.81334454E-02	-1.66951895E-02
3.00000000E-01	9.53375228E-01	3.06366103E-01	3.07707131E-01	4.59657943E-02	-2.38579508E-02
4.00000000E-01	9.51883579E-01	3.40952245E-01	3.42822821E-01	5.30904899E-02	-3.03735562E-02
5.00000000E-01	9.49945796E-01	3.72467115E-01	3.74902939E-01	5.95992919E-02	-3.63259207E-02
6.00000000E-01	9.47561881E-01	4.01302165E-01	4.04324791E-01	6.55687528E-02	-4.17850523E-02
7.00000000E-01	9.44731833E-01	4.27785070E-01	4.31403642E-01	7.10632429E-02	-4.68098185E-02
8.00000000E-01	9.41455652E-01	4.52192201E-01	4.56414199E-01	7.61372812E-02	-5.14500772E-02
9.00000000E-01	9.37733338E-01	4.74758286E-01	4.79579563E-01	8.08373503E-02	-5.57483373E-02
1.00000000E+00	9.33564891E-01	4.95683963E-01	5.01098264E-01	8.52033243E-02	-5.97410642E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	5.94714E-01	8.26677E+03	9.91822E+03	1.28789E-05	4.74139E+01
1.00000E-01	5.94619E-01	1.05102E+04	1.25271E+04	9.49455E-06	3.49544E+01
2.00000E-01	5.94246E-01	1.16410E+04	1.48688E+04	8.05397E-06	2.96509E+01
3.00000E-01	5.93595E-01	1.23382E+04	1.69823E+04	7.17097E-06	2.64001E+01
4.00000E-01	5.92666E-01	1.28449E+04	1.88995E+04	6.53943E-06	2.40750E+01
5.00000E-01	5.91460E-01	1.32456E+04	2.06464E+04	6.05406E-06	2.22881E+01
6.00000E-01	5.89975E-01	1.35798E+04	2.22447E+04	5.66356E-06	2.08505E+01
7.00000E-01	5.88213E-01	1.38680E+04	2.37127E+04	5.34009E-06	1.96597E+01
8.00000E-01	5.86173E-01	1.41229E+04	2.50657E+04	5.06569E-06	1.86494E+01
9.00000E-01	5.83856E-01	1.43526E+04	2.63165E+04	4.82872E-06	1.77770E+01
1.00000E+00	5.81260E-01	1.45637E+04	2.74765E+04	4.61998E-06	1.70086E+01

QRYPC 2.93764008E+03 6.41170279E+03 QRYPL 2.05716229E+03 4.44448566E+03 QRYD-5.19505968E-02 QRY1 1.11874378E-01

PRATIO 9.90507700E-01 GRATIO 0.

BODY AND SHOCK PROPERTIES
 X 1.050000000-01 DELTA 3.83208388D-02 IO(3) 9.78211322D-01
 IO(4) 0. IO(5) 2.03081994D-01 SMALRB 0. IO(2) 1.13298319D+00 IO(3) 9.78211322D-01
 I1(4)-1.04524123E-01 I1(5) 8.78222874E-01 RBX 1.00000000E+00 I1(2) 1.75259612E+00 I1(3) 1.11412357E+00
 DDELX-2.76967246E-04 DWDX-9.96662369E-01 OI0DX(2) 1.08126279E+01 DI0DX(3) 2.67081357E-01 DI0DX(4) 0.
 DI0DX(5) 1.93626233E+00 DSMLRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	P0UM	STAENT	CAPH	AUDUM	V
0.	9.50229681E-01	1.78940307E-01	1.79245373E-01	2.47008461E-02	0.
1.00000000E-01	9.50123922E-01	2.25746871E-01	2.26450757E-01	3.64864208E-02	-8.74719488E-03
2.00000000E-01	9.49592158E-01	2.67754014E-01	2.69002002E-01	4.71100159E-02	-1.66319743E-02
3.00000000E-01	9.48634390E-01	3.05662974E-01	3.07555074E-01	5.67354032E-02	-2.37758888E-02
4.00000000E-01	9.47250618E-01	3.40044871E-01	3.42648195E-01	6.54969590E-02	-3.02786720E-02
5.00000000E-01	9.45440841E-01	3.71369521E-01	3.74727135E-01	7.35059765E-02	-3.62229249E-02
6.00000000E-01	9.43205059E-01	4.00026927E-01	4.04164239E-01	8.08554176E-02	-4.16776435E-02
7.00000000E-01	9.40543273E-01	4.26343520E-01	4.31272950E-01	8.76235383E-02	-4.67009090E-02
8.00000000E-01	9.37455482E-01	4.50594597E-01	4.56319012E-01	9.38766859E-02	-5.13419640E-02
9.00000000E-01	9.33941686E-01	4.73013947E-01	4.79529212E-01	9.96714813E-02	-5.56428323E-02
1.00000000E+00	9.30001886E-01	4.93801385E-01	5.01098264E-01	1.05056538E-01	-5.96395948E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GN/CC)	(GN/CC)
0.	5.91636E-01	8.26562E+03	9.91891E+03	1.28131E-05	4.71716E+01
1.00000E-01	5.91570E-01	1.04996E+04	1.25135E+04	9.45831E-06	3.48210E+01
2.00000E-01	5.91239E-01	1.16279E+04	1.48420E+04	8.02766E-06	2.95540E+01
3.00000E-01	5.90643E-01	1.23235E+04	1.69433E+04	7.15080E-06	2.63258E+01
4.00000E-01	5.89781E-01	1.28290E+04	1.88492E+04	6.52375E-06	2.40173E+01
5.00000E-01	5.88655E-01	1.32285E+04	2.05855E+04	6.04192E-06	2.22435E+01
6.00000E-01	5.87263E-01	1.35616E+04	2.21741E+04	5.65437E-06	2.08167E+01
7.00000E-01	5.85605E-01	1.38486E+04	2.36328E+04	5.33344E-06	1.96352E+01
8.00000E-01	5.83683E-01	1.41024E+04	2.49771E+04	5.06131E-06	1.86333E+01
9.00000E-01	5.81495E-01	1.43309E+04	2.62198E+04	4.82644E-06	1.77686E+01
1.00000E+00	5.79042E-01	1.45408E+04	2.73721E+04	4.61963E-06	1.70073E+01

QRYPC 2.90033140E+03 6.31793138E+03 QRYPL 1.99781535E+03 4.28207326E+03 QRYO-5.09452883E-02 QRY1 1.10249921E-01
 PRATIO 9.85381121E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 1.25000000D-01 DELTA 3.83159731D-02
 IO(4) 0. IO(5) 2.41492217D-01
 I1(4)-1.23936746E-01 I1(5) 1.04353150E+00
 DDELDX-2.08366330E-04 DMDX-9.96601154E-01
 DIJDX(5) 1.90463643E+00 DSMALRBDX 0.

W 1.44559565D+00
 SMALRBD 0.
 RBX 1.00000000E+00
 DIJDX(2) 1.07578414E+01
 DIJDX(3) 3.17640042E-01
 DIJDX(4) 0.

IO(2) 1.34868951D+00
 I1(2) 2.08248875E+00
 THETAB 1.44579633E+00
 Q 1.00000000E+00

DISTRIBUTION ACROSS SHOCK LAYER

ETA	POUM	STAENT	CAPH	AUDUM	V
0.	9.44240951E-01	1.78621036E-01	1.79056940E-01	2.95263735E-02	0.
1.00000000E-01	9.44192935E-01	2.25233350E-01	2.26216904E-01	4.34873773E-02	-8.71523872E-03
2.00000000E-01	9.43743723E-01	2.67038946E-01	2.68748701E-01	5.60782814E-02	-1.65751846E-02
3.00000000E-01	9.42893316E-01	3.04743379E-01	3.07301761E-01	6.74913396E-02	-2.36998533E-02
4.00000000E-01	9.41641713E-01	3.38920791E-01	3.42401436E-01	7.78844433E-02	-3.01878093E-02
5.00000000E-01	9.39988915E-01	3.70043104E-01	3.74513831E-01	8.73884703E-02	-3.61207540E-02
6.00000000E-01	9.37934921E-01	3.98501764E-01	4.03984509E-01	9.61128250E-02	-4.15669838E-02
7.00000000E-01	9.35479732E-01	4.24624178E-01	4.3132791E-01	1.04149669E-01	-4.65840309E-02
8.00000000E-01	9.32623347E-01	4.48686276E-01	4.56222790E-01	1.11577189E-01	-5.12207039E-02
9.00000000E-01	9.29365767E-01	4.70922232E-01	4.79480035E-01	1.18462149E-01	-5.55186807E-02
1.00000000E+00	9.25706991E-01	4.91532072E-01	5.01098264E-01	1.24861904E-01	-5.95137650E-02

PATH LENGTH (Y/DELTA)

PATH LENGTH (Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	5.87908E-01	8.24956E+03	9.90122E+03	1.27643E-05	4.69920E+01
1.00000E-01	5.87878E-01	1.04790E+04	1.24850E+04	9.42396E-06	3.46945E+01
2.00000E-01	5.87598E-01	1.16092E+04	1.48023E+04	7.99914E-06	2.94490E+01
3.00000E-01	5.87068E-01	1.23046E+04	1.68924E+04	7.12763E-06	2.62405E+01
4.00000E-01	5.86289E-01	1.28093E+04	1.87869E+04	6.50508E-06	2.39486E+01
5.00000E-01	5.85260E-01	1.32078E+04	2.05120E+04	6.02712E-06	2.21890E+01
6.00000E-01	5.83981E-01	1.35397E+04	2.20895E+04	5.64295E-06	2.07746E+01
7.00000E-01	5.82453E-01	1.38255E+04	2.35375E+04	5.32507E-06	1.96043E+01
8.00000E-01	5.80674E-01	1.40778E+04	2.48713E+04	5.05573E-06	1.86128E+01
9.00000E-01	5.78646E-01	1.43048E+04	2.61039E+04	4.82351E-06	1.77578E+01
1.00000E+00	5.76368E-01	1.45131E+04	2.72463E+04	4.61916E-06	1.70055E+01

QRYPC 2.85462755E+03 6.20560099E+03 QRYPL 1.99287465E+03 4.20834463E+03 QRYD-5.04185379E-02 QRY1 1.08314734E-01

PRATIO 9.79170853E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 1.45000000D-01 DELTA 3.83124836D-02 W 1.42566200D+00 IO(2) 1.56315710D+00 IO(3) 9.90908112D-01
 IO(4) 0. IO(5) 2.79194999D-01 SMALRB 0. I1(2) 2.41128508E+00 I1(3) 1.26939981E+00
 I1(4)-1.43143778E-01 I1(5) 1.20829077E+00 RBX 1.00000000E+00 THEIAB 1.42579633E+00 Q 1.00000000E+00
 DDELDX-1.39471072E-04 DWDX-9.96656631E-01 DIODX(2) 1.06883807E+01 DIODX(3) 3.67075703E-01 DIODX(4) 0.
 DIODX(5) 1.86533189E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER ETA PDUM

V

AUDUM

CAPH

STAENT

0.	9.37226776E-01	1.78019951E-01	1.78609687E-01	3.43434346E-02	0.
1.00000000E-01	9.37246479E-01	2.24483970E-01	2.25795736E-01	5.04785534E-02	-8.68506754E-03
2.00000000E-01	9.36894233E-01	2.66111441E-01	2.68362648E-01	6.50341729E-02	-1.65218384E-02
3.00000000E-01	9.36170038E-01	3.03617861E-01	3.06957039E-01	7.82314012E-02	-2.36263424E-02
4.00000000E-01	9.35073893E-01	3.37584583E-01	3.42110214E-01	9.02519170E-02	-3.00973832E-02
5.00000000E-01	9.33605800E-01	3.68488783E-01	3.74262777E-01	1.01246383E-01	-3.60160676E-02
6.00000000E-01	9.31765758E-01	3.96725747E-01	4.03783194E-01	1.11340795E-01	-4.14502232E-02
7.00000000E-01	9.29553767E-01	4.22625680E-01	4.30981972E-01	1.20641331E-01	-4.64570085E-02
8.00000000E-01	9.26969826E-01	4.46466550E-01	4.56122628E-01	1.29238097E-01	-5.10849322E-02
9.00000000E-01	9.24013937E-01	4.68484096E-01	4.79430251E-01	1.37208065E-01	-5.53754289E-02
1.00000000E+00	9.20686099E-01	4.88879123E-01	5.01098264E-01	1.44617373E-01	-5.93641040E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)

(ATM)

(DEG K)

(CAL/GM)

(GM/CC)

0.	5.83540E-01	8.22113E+03	9.86790E+03	1.27274E-05	4.68563E+01
1.00000E-01	5.83553E-01	1.04496E+04	1.24435E+04	9.39022E-06	3.45703E+01
2.00000E-01	5.83333E-01	1.15852E+04	1.47509E+04	7.96799E-06	2.93343E+01
3.00000E-01	5.82882E-01	1.22816E+04	1.68300E+04	7.10131E-06	2.61436E+01
4.00000E-01	5.82200E-01	1.27859E+04	1.87128E+04	6.48340E-06	2.38688E+01
5.00000E-01	5.81286E-01	1.31835E+04	2.04259E+04	6.00967E-06	2.21247E+01
6.00000E-01	5.80140E-01	1.35141E+04	2.19911E+04	5.62935E-06	2.07245E+01
7.00000E-01	5.78763E-01	1.37984E+04	2.34267E+04	5.31501E-06	1.95673E+01
8.00000E-01	5.77154E-01	1.40492E+04	2.47483E+04	5.04899E-06	1.85879E+01
9.00000E-01	5.75314E-01	1.42743E+04	2.59687E+04	4.81993E-06	1.77447E+01
1.00000E+00	5.73242E-01	1.44807E+04	2.70993E+04	4.61856E-06	1.70033E+01

QRYPC 2.80095142E+03 6.07558117E+03 QRYPL 1.93600196E+03 4.15143070E+03 QRYD-4.92687272E-02 QRYI 1.06370449E-01

PRATIO 9.71897205E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 1.650000000-01 DELTA 3.83103639D-02 IO(4) 0. SMALRB 0. W 1.40572838D+00 IO(2) 1.77612638D+00 IO(3) 9.98733286D-01
 IO(4) 0. IO(5) 3.16053580D-01 SMALRB 0. IO(2) 1.77612638D+00 IO(3) 9.98733286D-01
 IO(4) 0. IO(5) 3.16053580D-01 SMALRB 0. IO(2) 1.77612638D+00 IO(3) 9.98733286D-01
 IO(4) 0. IO(5) 3.16053580D-01 SMALRB 0. IO(2) 1.77612638D+00 IO(3) 9.98733286D-01
 DDEL0X-7.05505647E-05 DWDX-9.96643946E-01 OI0DX(2) 1.06071802E+01 OI0DX(3) 4.15245035E-01 OI0DX(4) 0.
 DI0DX(5) 1.81981323E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER
ETA

PATH LENGTH (V/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)	STAENT	CAPH	AUDUM	V
0.	9.29204776E-01	1.77179169E-01	1.77945434E-01	3.91475422E-02	0.				
1.00000000E-01	9.29301938E-01	2.23526002E-01	2.25214094E-01	5.74562596E-02	-8.65802228E-03				
2.00000000E-01	9.29060673E-01	2.64988095E-01	2.67859817E-01	7.39743604E-02	-1.64692786E-02				
3.00000000E-01	9.28480981E-01	3.02295571E-01	3.06529178E-01	8.89522849E-02	-2.35521999E-02				
4.00000000E-01	9.27562862E-01	3.36040473E-01	3.41753551E-01	1.02595851E-01	-3.00041154E-02				
5.00000000E-01	9.26306315E-01	3.66707836E-01	3.73973663E-01	1.15075768E-01	-3.59057521E-02				
6.00000000E-01	9.24711342E-01	3.94598751E-01	4.03558144E-01	1.26534817E-01	-4.13246299E-02				
7.00000000E-01	9.22777941E-01	4.20347725E-01	4.30817680E-01	1.37093338E-01	-4.63176563E-02				
8.00000000E-01	9.20506114E-01	4.43935911E-01	4.56015974E-01	1.46853471E-01	-5.09331329E-02				
9.00000000E-01	9.17895859E-01	4.65701310E-01	4.79378301E-01	1.55902475E-01	-5.52123224E-02				
1.00000000E+00	9.14947177E-01	4.85846731E-01	5.01098264E-01	1.64315336E-01	-5.91906861E-02				

QRYPC 2.73974577E+03 5.92886635E+03 QRYPL 1.93599575E+03 4.05422260E+03 QRYD-4.86320666E-02 QRY1 1.03833423E-01

PRATIO 9.63578451E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 1.85000000D-01 DELTA 3.83096382D-02 W 1.38579687D+00 IO(2) 1.98737110D+00 IO(3) 1.00750825D+00
 IO(4) 0. IO(5) 3.51948290D-01 SMALRB 0. RBX 1.00000000E+00 THETAB 1.38579633E+00 I1(3) 1.4727213E+00
 I1(4)-1.80806933E-01 I1(5) 1.53580472E+00 DIODX(2) 1.05149688E+01 DIODX(3) 4.61990177E-01 DIODX(4) 0.
 DDELX 5.66455166E-07 DWDX-9.96497235E-01 DMSALRBOX 0.
 DIODX(5) 1.76848160E+00

DISTRIBUTION ACROSS SHOCK LAYER ETA

	PDUM	STAENT	CAPH	AUDUM	V
0.	9.20192453E-01	1.76127181E-01	1.77092386E-01	4.39364289E-02	0.
1.00000000E-01	9.20376591E-01	2.22377955E-01	2.24490027E-01	6.44179242E-02	-8.62990113E-03
2.00000000E-01	9.20259979E-01	2.63680291E-01	2.67250881E-01	8.28957684E-02	-1.64155616E-02
3.00000000E-01	9.19842617E-01	3.00782997E-01	3.06023625E-01	9.96502684E-02	-2.34750890E-02
4.00000000E-01	9.19124507E-01	3.34291802E-01	3.41341330E-01	1.14911775E-01	-2.99355421E-02
5.00000000E-01	9.18105647E-01	3.64701835E-01	3.73646116E-01	1.28871337E-01	-3.57874193E-02
6.00000000E-01	9.16786037E-01	3.92421676E-01	4.03307733E-01	1.41688741E-01	-4.11880466E-02
7.00000000E-01	9.15165678E-01	4.17791400E-01	4.30637883E-01	1.53498652E-01	-4.61641660E-02
8.00000000E-01	9.13244570E-01	4.41096312E-01	4.55901007E-01	1.64415367E-01	-5.07639363E-02
9.00000000E-01	9.11022712E-01	4.62577509E-01	4.79323076E-01	1.74536525E-01	-5.50284974E-02
1.00000000E+00	9.08500106E-01	4.82440094E-01	5.01098264E-01	1.83946031E-01	-5.89932036E-02

PATH LENGTH (Y/DELTA)

	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	5.72934E-01	8.13634E+03	9.76298E+03	1.26728E-05	4.66550E+01
1.00000E-01	5.73049E-01	1.03664E+04	1.23267E+04	9.32094E-06	3.43152E+01
2.00000E-01	5.72976E-01	1.15223E+04	1.46162E+04	7.89643E-06	2.90709E+01
3.00000E-01	5.72717E-01	1.22235E+04	1.66728E+04	7.03872E-06	2.59132E+01
4.00000E-01	5.72269E-01	1.27280E+04	1.85303E+04	6.43088E-06	2.36754E+01
5.00000E-01	5.71635E-01	1.31238E+04	2.02159E+04	5.96687E-06	2.19672E+01
6.00000E-01	5.70813E-01	1.34517E+04	2.17525E+04	5.59566E-06	2.06005E+01
7.00000E-01	5.69805E-01	1.37326E+04	2.31588E+04	5.28991E-06	1.94749E+01
8.00000E-01	5.68608E-01	1.39796E+04	2.44506E+04	5.03200E-06	1.85254E+01
9.00000E-01	5.67225E-01	1.42009E+04	2.56413E+04	4.81030E-06	1.77092E+01
1.00000E+00	5.65654E-01	1.44022E+04	2.67423E+04	4.61684E-06	1.69970E+01

QRYPC 2.67153002E+03 5.76702806E+03 QRYPL 1.87854596E+03 3.94663699E+03 QRYD-4.73250281E-02 QRY1 1.01031164E-01

PRATIO 9.54232739E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 2.05000000D-01 DELTA 3.83103801D-02 IO(4) 0. IO(5) 3.86762992D-01 IO(3) 1.01720284D+00
 IO(4) 0. IO(5) 3.86762992D-01 IO(3) 1.01720284D+00
 II(4)-1.99189851E-01 II(5) 1.69834827E+00 SMALRB 0. SMALRB 0. II(2) 3.38925195E+00 II(3) 1.59108576E+00
 DOELDX 7.69460658E-05 DWDX-9.961822482E-01 DIODX(2) 1.04116964E+01 THETAB 1.36579632E+00 THETAB 1.36579632E+00
 DIODX(5) 1.71138488E+00 DSMALRBDX 0. DIODX(3) 5.07135685E-01 DIODX(4) 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDM	STAENT	CAPH	AUDUM	V
0.	9.1020829E-01	1.74881619E-01	1.76067867E-01	4.87082668E-02	0.
1.0000000E-01	9.10489221E-01	2.21051342E-01	2.23634537E-01	7.13611572E-02	-8.60086490E-03
2.0000000E-01	9.10510585E-01	2.62195248E-01	2.66542250E-01	9.17952909E-02	-1.63593108E-02
3.0000000E-01	9.10272922E-01	2.990844503E-01	3.05443536E-01	1.10321426E-01	-2.33933265E-02
4.0000000E-01	9.09776231E-01	3.3241222E-01	3.40874506E-01	1.27194877E-01	-2.97998499E-02
5.0000000E-01	9.09020513E-01	3.62472630E-01	3.73279702E-01	1.42627350E-01	-3.56592618E-02
6.0000000E-01	9.08005767E-01	3.89896286E-01	4.03030850E-01	1.56795874E-01	-4.10387765E-02
7.0000000E-01	9.06731994E-01	4.14958961E-01	4.30441179E-01	1.69849619E-01	-4.59950314E-02
8.0000000E-01	9.05199193E-01	4.37950962E-01	4.55776498E-01	1.81915172E-01	-5.05760888E-02
9.0000000E-01	9.03407365E-01	4.59117122E-01	4.79263834E-01	1.93100652E-01	-5.48229996E-02
1.0000000E+00	9.01356509E-01	4.78665333E-01	5.01098264E-01	2.03498962E-01	-5.87710368E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	5.66718E-01	8.08342E+03	9.69393E+03	1.26492E-05	4.65683E+01
1.00000E-01	5.66893E-01	1.03127E+04	1.22532E+04	9.28497E-06	3.41828E+01
2.00000E-01	5.66906E-01	1.14837E+04	1.45339E+04	7.85568E-06	2.89208E+01
3.00000E-01	5.66758E-01	1.21889E+04	1.65787E+04	7.00231E-06	2.57791E+01
4.00000E-01	5.66449E-01	1.26935E+04	1.84221E+04	6.39999E-06	2.35617E+01
5.00000E-01	5.65978E-01	1.30885E+04	2.00924E+04	5.94152E-06	2.18738E+01
6.00000E-01	5.65347E-01	1.34149E+04	2.16125E+04	5.57559E-06	2.05266E+01
7.00000E-01	5.64554E-01	1.36939E+04	2.30018E+04	5.27486E-06	1.94195E+01
8.00000E-01	5.63599E-01	1.39387E+04	2.42762E+04	5.02174E-06	1.84876E+01
9.00000E-01	5.62484E-01	1.41575E+04	2.54495E+04	4.80464E-06	1.76884E+01
1.00000E+00	5.61207E-01	1.43562E+04	2.65331E+04	4.61565E-06	1.69926E+01

QRYPC 2.59661584E+03 5.59033428E+03 QRYPL 1.82792075E+03 3.84873570E+03 QRYVO-4.60193016E-02 QRYV 9.81751193E-02

PRATIO 9.43879795E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 2.250000000-01 DELTA 3.83127312D-02 IO(3) 1.02778317D+00
 IO(4) 0. IO(5) 4.20381189D-01 I1(2) 3.71171511E+00 I1(3) 1.72110535E+00
 I1(4)-2.17221524E-01 I1(5) 1.85993400E+00 THEIAB 1.34579633E+00 Q 1.00000000E+00
 DDELDX 1.62329519E-04 DMDX-9.95667413E-01 DIODX(2) 1.02969798E+01 DIODX(3) 5.50487991E-01 DIODX(4) 0.
 DIJDX(5) 1.64844638E+00 DSMALRBDX 0. W 1.34595266D+00

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	8.99275317E-01	1.73453092E-01	1.74882137E-01	5.34611120E-02	0.
1.00000000E-01	8.99660982E-01	2.19553167E-01	2.22654037E-01	7.82834065E-02	-8.57028597E-03
2.00000000E-01	8.99833265E-01	2.60537526E-01	2.65737548E-01	1.00669612E-01	-1.62994741E-02
3.00000000E-01	8.99792166E-01	2.97203144E-01	3.04790570E-01	1.20961575E-01	-2.33055921E-02
4.00000000E-01	8.99537686E-01	3.30191035E-01	3.40353414E-01	1.39440040E-01	-2.96855715E-02
5.00000000E-01	8.99069824E-01	3.60022376E-01	3.72873943E-01	1.56337717E-01	-3.55197592E-02
6.00000000E-01	8.98388581E-01	3.87125080E-01	4.02726538E-01	1.71849135E-01	-4.08753191E-02
7.00000000E-01	8.97493956E-01	4.11853640E-01	4.30226572E-01	1.86138161E-01	-4.58088292E-02
8.00000000E-01	8.96385949E-01	4.34594136E-01	4.55641596E-01	1.99343816E-01	-5.03682883E-02
9.00000000E-01	8.95064561E-01	4.55325718E-01	4.79200074E-01	2.11584808E-01	-5.45946825E-02
1.00000000E+00	8.93529791E-01	4.74529505E-01	5.01098264E-01	2.22963114E-01	-5.85232211E-02

PATH LENGTH (Y/DELTA)

PATH LENGTH (Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(IND)
0.	5.59911E-01	8.02519E+03	9.61475E+03	1.26256E-05	4.64815E+01
1.00000E-01	5.60151E-01	1.02518E+04	1.21701E+04	9.24691E-06	3.40427E+01
2.00000E-01	5.60258E-01	1.14401E+04	1.44420E+04	7.81153E-06	2.87583E+01
3.00000E-01	5.60233E-01	1.21494E+04	1.64744E+04	6.96247E-06	2.56325E+01
4.00000E-01	5.60074E-01	1.26552E+04	1.83030E+04	6.36602E-06	2.34366E+01
5.00000E-01	5.59783E-01	1.30494E+04	1.99565E+04	5.91352E-06	2.17707E+01
6.00000E-01	5.59359E-01	1.33743E+04	2.14589E+04	5.55334E-06	2.04447E+01
7.00000E-01	5.58802E-01	1.36513E+04	2.28296E+04	5.25812E-06	1.93579E+01
8.00000E-01	5.58112E-01	1.38937E+04	2.40852E+04	5.01027E-06	1.84454E+01
9.00000E-01	5.57289E-01	1.41100E+04	2.52393E+04	4.79824E-06	1.76648E+01
1.00000E+00	5.56334E-01	1.43057E+04	2.63038E+04	4.61421E-06	1.69873E+01

QRYPC 2.51559784E+03 5.40053278E+03 QRYPL 1.76663843E+03 3.72301277E+03 QRYD-4.45392456E-02 QRY1 9.48933713E-02

PRATIO 9.32561824E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 2.450000000-01 DELTA 3.83169157D-02 W 1.32604795D+00 IO(2) 2.60851799D+00 IO(3) 1.03921132D+00
 IO(4) 0. IO(5) 4.52684640D-01 SMALRB 0. IO(6) 4.03203233E+00 IO(7) 1.86210503E+00
 I1(4)-2.34859275E-01 I1(5) 2.02044440E+00 RBX 1.00000000E+00 THETAB 1.32579632E+00 Q 1.00000000E+00
 DDELDX 2.61268753E-04 DWDX-9.94907365E-01 DIODX(2) 1.01702586E+01 DIODX(3) 5.91834296E-01 DIODX(4) 0.
 DIODX(5) 1.57955385E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER ETA

ETA	PDOUM	STAENT	CAPH	AUDUM	V
0.	8.87416455E-01	1.71847739E-01	1.73540931E-01	5.81926496E-02	0.
1.	8.87916117E-01	2.17887586E-01	2.21551998E-01	8.51817581E-02	-8.53763806E-03
2.	8.88251828E-01	2.58710048E-01	2.64838611E-01	1.09515046E-01	-1.62351432E-02
3.	8.88423587E-01	2.95141228E-01	3.04065425E-01	1.31566142E-01	-2.32107081E-02
4.	8.88431394E-01	3.27843449E-01	3.39777993E-01	1.51641731E-01	-2.95513482E-02
5.	8.88275250E-01	3.57353595E-01	3.72428326E-01	1.69995903E-01	-3.53674415E-02
6.	8.87955155E-01	3.84111234E-01	4.02394096E-01	1.86840965E-01	-4.06961482E-02
7.	8.87471108E-01	4.08479545E-01	4.29993321E-01	2.02355690E-01	-4.56040206E-02
8.	8.86823109E-01	4.30761094E-01	4.55495698E-01	2.16691685E-01	-5.01390181E-02
9.	8.86011159E-01	4.51209889E-01	4.79131444E-01	2.29978366E-01	-5.43420792E-02
1.	8.85035258E-01	4.70040672E-01	5.01098264E-01	2.42326870E-01	-5.82483610E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY (Y/DELTA) (ATM) (DEG K) (CAL/GM) (CM/CC) DENSITY(ND)

0.	5.52527E-01	7.96200E+03	9.52576E+03	1.26024E-05	4.63958E+01
1.	5.52838E-01	1.01822E+04	1.20778E+04	9.20839E-06	3.39009E+01
2.	5.53047E-01	1.13916E+04	1.43407E+04	7.76401E-06	2.85834E+01
3.	5.53154E-01	1.21063E+04	1.63601E+04	6.91921E-06	2.54732E+01
4.	5.53159E-01	1.26131E+04	1.81728E+04	6.32896E-06	2.33002E+01
5.	5.53062E-01	1.30066E+04	1.98086E+04	5.88289E-06	2.16580E+01
6.	5.52863E-01	1.33299E+04	2.12918E+04	5.52892E-06	2.03548E+01
7.	5.52561E-01	1.36048E+04	2.26426E+04	5.23968E-06	1.92900E+01
8.	5.52158E-01	1.38447E+04	2.38777E+04	4.99758E-06	1.83987E+01
9.	5.51652E-01	1.40582E+04	2.50112E+04	4.79108E-06	1.76385E+01
1.	5.51045E-01	1.42509E+04	2.60550E+04	4.61247E-06	1.69809E+01

QRYPC 2.42895748E+03 5.19897229E+03 QRYPL 1.73237704E+03 3.58917941E+03 QRYO-4.32817548E-02 QRY1 9.14049630E-02

PRATIO 9.20244273E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 2.65000000-01 DELTA 3.83232593D-02
 IO(4) 0. IO(5) 4.83552913D-01
 I1(4)-2.52055917E-01 I1(5) 2.17975511E+00
 DDELX 3.7945737E-04 DWDX-9.9387718E-01
 DIODX(5) 1.50458006E+00 DSMALRBDX 0.

W 1.30616179D+00
 SMALRB 0.
 RBX 1.00000000E+00
 DIODX(2) 1.00308012E+01
 DIODX(3) 6.30937633E-01
 DIODX(4) 0.

IO(2) 2.81058505D+00
 I1(2) 4.34995541E+00
 THETAB 1.30579633E+00
 Q 1.00000000E+00

IO(3) 1.05144491D+00
 I1(3) 2.01374188E+00
 Q 1.00000000E+00

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	8.74660672E-01	1.70068860E-01	1.72047066E-01	6.29000234E-02	0.
1.00000000E-01	8.75282720E-01	2.16056993E-01	2.20329994E-01	9.20527569E-02	-8.50241317E-03
2.00000000E-01	8.75793862E-01	2.56714783E-01	2.63846124E-01	1.18327348E-01	-1.61654142E-02
3.00000000E-01	8.76194096E-01	2.92900721E-01	3.03268163E-01	1.42129968E-01	-2.31074635E-02
4.00000000E-01	8.76483422E-01	3.25300783E-01	3.39147924E-01	1.63793798E-01	-2.94257332E-02
5.00000000E-01	8.76661846E-01	3.54469264E-01	3.71942318E-01	1.83594715E-01	-3.52005832E-02
6.00000000E-01	8.76729362E-01	3.80858633E-01	4.02032914E-01	2.01763107E-01	-4.04995061E-02
7.00000000E-01	8.7685970E-01	4.04841669E-01	4.29740853E-01	2.18492874E-01	-4.53787534E-02
8.00000000E-01	8.76531673E-01	4.26728107E-01	4.55338355E-01	2.33948382E-01	-4.98863621E-02
9.00000000E-01	8.76266468E-01	4.46777312E-01	4.79057694E-01	2.48269874E-01	-5.40632344E-02
1.00000000E+00	8.75890358E-01	4.65208025E-01	5.01098264E-01	2.61577743E-01	-5.79444828E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	(GM/CC)
0.	5.44585E-01	7.89595E+03	9.42716E+03	1.25754E-05	4.62967E+01
1.00000E-01	5.44972E-01	1.01034E+04	1.19763E+04	9.16984E-06	3.37590E+01
2.00000E-01	5.45291E-01	1.13338E+04	1.42301E+04	7.71323E-06	2.83964E+01
3.00000E-01	5.45540E-01	1.20590E+04	1.62359E+04	6.87257E-06	2.53015E+01
4.00000E-01	5.45720E-01	1.25672E+04	1.80319E+04	6.2885E-06	2.31525E+01
5.00000E-01	5.45831E-01	1.29600E+04	1.96487E+04	5.84962E-06	2.15355E+01
6.00000E-01	5.45873E-01	1.32818E+04	2.11115E+04	5.50233E-06	2.02569E+01
7.00000E-01	5.45846E-01	1.35544E+04	2.24409E+04	5.21952E-06	1.92158E+01
8.00000E-01	5.45750E-01	1.37917E+04	2.36541E+04	4.98362E-06	1.83473E+01
9.00000E-01	5.45585E-01	1.40023E+04	2.47655E+04	4.78313E-06	1.76092E+01
1.00000E+00	5.45351E-01	1.41918E+04	2.57871E+04	4.61039E-06	1.69732E+01

QRYPC 2.33727532E+03 4.98710880E+03 QRYPL 1.68195499E+03 3.44851300E+03 QRYD-4.18037388E-02 QRY1 8.77383237E-02

PRATIO 9.07016621E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 2.850000000-01 DELTA 3.83322171D-02 W 1.28630124D+00 IO(2) 3.00973490D+00 IO(3) 1.06443651D+00
 IO(4) 0. IO(5) 5.12863153D-01 SMALLRB 0. SMALLRB 0. I1(2) 4.66521638E+00 I1(3) 2.17565058E+00
 I1(4)-2.88757589E-01 I1(5) 2.3373183E+00 RBX 1.00000000E+00 THETAB 1.28579632E+00 Q 1.00000000E+00
 DDELDX 5.24266711E-04 DMDX-9.92366022E-01 DIODX(2) 9.87766111E+00 DIODX(3) 6.67528732E-01 DIODX(4) 0.
 DIODX(5) 1.42338700E+00 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER
ETA

ETA	POUM	STAENT	CAPH	AUDUM	V
0.	8.61041314E-01	1.68117934E-01	1.70401437E-01	6.75796349E-02	0.
1.00000000E-01	8.61793750E-01	2.14062706E-01	2.18988358E-01	9.88921797E-02	-8.46405137E-03
2.00000000E-01	8.62491727E-01	2.54553201E-01	2.62760025E-01	1.27101465E-01	-1.60892648E-02
3.00000000E-01	8.63135245E-01	2.90483541E-01	3.02398472E-01	1.52647036E-01	-2.29944534E-02
4.00000000E-01	8.63724305E-01	3.22565663E-01	3.38462735E-01	1.75889173E-01	-2.92770039E-02
5.00000000E-01	8.64258907E-01	3.51372945E-01	3.71415385E-01	1.97125985E-01	-3.50174976E-02
6.00000000E-01	8.64739050E-01	3.77371964E-01	4.01642469E-01	2.16606268E-01	-4.02831863E-02
7.00000000E-01	8.65164734E-01	4.00945986E-01	4.29468713E-01	2.34539294E-01	-4.51306382E-02
8.00000000E-01	8.65535960E-01	4.22412564E-01	4.55169228E-01	2.51102363E-01	-4.96377789E-02
9.00000000E-01	8.65852727E-01	4.42036895E-01	4.78978638E-01	2.66446682E-01	-5.37554809E-02
1.00000000E+00	8.66115035E-01	4.60042071E-01	5.01098264E-01	2.80701995E-01	-5.76088152E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(CM/CC)	DENSITY(ND)
0.	5.36105E-01	7.82778E+03	9.31901E+03	1.25440E-05	4.61810E+01
1.00000E-01	5.36574E-01	1.00167E+04	1.18658E+04	9.12953E-06	3.36105E+01
2.00000E-01	5.37008E-01	1.12790E+04	1.41102E+04	7.65932E-06	2.81980E+01
3.00000E-01	5.37409E-01	1.20075E+04	1.61019E+04	6.82264E-06	2.51177E+01
4.00000E-01	5.37776E-01	1.25174E+04	1.78803E+04	6.24572E-06	2.29937E+01
5.00000E-01	5.38109E-01	1.29097E+04	1.94771E+04	5.81374E-06	2.14034E+01
6.00000E-01	5.38408E-01	1.32298E+04	2.09183E+04	5.47356E-06	2.01510E+01
7.00000E-01	5.38673E-01	1.35002E+04	2.22250E+04	5.19764E-06	1.91392E+01
8.00000E-01	5.38904E-01	1.37347E+04	2.34149E+04	4.96839E-06	1.82912E+01
9.00000E-01	5.39101E-01	1.39423E+04	2.45027E+04	4.77434E-06	1.75768E+01
1.00000E+00	5.39264E-01	1.41285E+04	2.55008E+04	4.60793E-06	1.69642E+01

QRYPC 2.24121519E+03 4.76650570E+03 QRYPL 1.58952427E+03 3.29917698E+03 QRYD-3.98432583E-02 QRY1 8.38906122E-02

PRATIO 8.92893447E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 3.05000000D-01 DELTA 3.83444130D-02 IO(3) 3.20568291D+00 IO(3) 1.07813296D+00
 IO(4) 0. IO(5) 5.40489908D-01 SMALRB 0. IO(2) 3.20568291D+00 IO(2) 3.20568291D+00
 I1(4)-2.84900603E-01 I1(5) 2.49422619E+00 RBX 1.00000000E+00 I1(2) 4.97751913E+00 I1(3) 2.34741564E+00
 DDELX 7.05349136E-04 DWDX-9.90361191E-01 DIODX(2) 9.70960478E+00 THETAB 1.26579633E+00 THETAB 1.26579633E+00
 DIJDX(5) 1.33582778E+00 DSMALRBDX 0. DIODX(3) 7.01294246E-01 DIODX(4) 0. DIODX(4) 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDU	STAENT	CAPH	AUDUM	V
0.	8.46598132E-01	1.65995312E-01	1.68603671E-01	7.22268580E-02	0.
1.00000000E-01	8.47488505E-01	2.11905474E-01	2.17526624E-01	1.05694712E-01	-8.42186945E-03
2.00000000E-01	8.48383998E-01	2.52226647E-01	2.61579788E-01	1.35831176E-01	-1.60554264E-02
3.00000000E-01	8.49284610E-01	2.87891834E-01	3.01455799E-01	1.63110079E-01	-2.28699049E-02
4.00000000E-01	8.50190343E-01	3.19641242E-01	3.37721885E-01	1.87919458E-01	-2.91129508E-02
5.00000000E-01	8.51101196E-01	3.48068972E-01	3.70847021E-01	2.10580135E-01	-3.48152962E-02
6.00000000E-01	8.52017169E-01	3.73656901E-01	4.01222321E-01	2.31359667E-01	-4.00442693E-02
7.00000000E-01	8.52938262E-01	3.96799639E-01	4.29176547E-01	2.50482960E-01	-4.48564655E-02
8.00000000E-01	8.53864475E-01	4.17823183E-01	4.54988066E-01	2.68140441E-01	-4.92998041E-02
9.00000000E-01	8.54795807E-01	4.36999018E-01	4.78894145E-01	2.84494424E-01	-5.34151295E-02
1.00000000E+00	8.55732260E-01	4.54554918E-01	5.01098264E-01	2.99684109E-01	-5.72374703E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	(GM/CC)
0.	5.27113E-01	7.75693E+03	9.20135E+03	1.25106E-05	4.60579E+01
1.00000E-01	5.27667E-01	9.91918E+03	1.17462E+04	9.09083E-06	3.34681E+01
2.00000E-01	5.28225E-01	1.12145E+04	1.39813E+04	7.60250E-06	2.79888E+01
3.00000E-01	5.28785E-01	1.19517E+04	1.59582E+04	6.76951E-06	2.49221E+01
4.00000E-01	5.29349E-01	1.24637E+04	1.77182E+04	6.19965E-06	2.28241E+01
5.00000E-01	5.29916E-01	1.28556E+04	1.92940E+04	5.77530E-06	2.12619E+01
6.00000E-01	5.30487E-01	1.31740E+04	2.07123E+04	5.44264E-06	2.00372E+01
7.00000E-01	5.31060E-01	1.34421E+04	2.19952E+04	5.17403E-06	1.90483E+01
8.00000E-01	5.31637E-01	1.36739E+04	2.31605E+04	4.95186E-06	1.82304E+01
9.00000E-01	5.32217E-01	1.38784E+04	2.42235E+04	4.76469E-06	1.75413E+01
1.00000E+00	5.32800E-01	1.40612E+04	2.51966E+04	4.60505E-06	1.69536E+01

QRYPC 2.14137542E+03 4.53871746E+03 QRYPL 1.53431179E+03 3.15038950E+03 QRYO-3.82305706E-02 QRY1 7.99738740E-02

PRATIO 8.77915975E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 3.25000000D-01 DELTA 3.83606954D-02
 IO(4) 0.
 IO(5) 5.66305055D-01
 I1(4)-3.00406843E-01 I1(5) 2.64906995E+00
 DDELX 9.35683578E-04 DWDX-9.87637842E-01
 DIODX(5) 1.24175159E+00 DSMALRBDX 0.
 W 1.246697744D+00
 SMALR 0.
 RBX 1.00000000E+00
 DIODX(2) 9.52501224E+00
 DIODX(3) 7.31860214E-01
 DIODX(4) 0.
 IO(3) 1.09247430D+00
 I1(3) 2.52855991E+00
 Q 1.00000000E+00

DISTRIBUTION ACROSS SHOCK LAYER
ETA

ETA	PDM	STAENT	CAPH	AUDUM	V
0.	8.31379482E-01	1.63700762E-01	1.66652618E-01	7.68356193E-02	0.
1.00000000E-01	8.32414801E-01	2.09585902E-01	2.15943864E-01	1.12453475E-01	-8.37497551E-03
2.00000000E-01	8.33517589E-01	2.49736686E-01	2.60304650E-01	1.44508580E-01	-1.59122265E-02
3.00000000E-01	8.34687846E-01	2.85128284E-01	3.00439509E-01	1.73510029E-01	-2.27314588E-02
4.00000000E-01	8.35925573E-01	3.16531480E-01	3.36924845E-01	1.99874334E-01	-2.89306081E-02
5.00000000E-01	8.37230770E-01	3.44562737E-01	3.70236795E-01	2.23945550E-01	-3.45905740E-02
6.00000000E-01	8.38603436E-01	3.69720395E-01	4.00772123E-01	2.46010379E-01	-3.97787695E-02
7.00000000E-01	8.40043571E-01	3.92411251E-01	4.28864095E-01	2.66309638E-01	-4.45518194E-02
8.00000000E-01	8.41551176E-01	4.12970349E-01	4.54794696E-01	2.85047091E-01	-4.89576350E-02
9.00000000E-01	8.43126250E-01	4.31675900E-01	4.78804126E-01	3.02396305E-01	-5.30370285E-02
1.00000000E+00	8.44768794E-01	4.48760673E-01	5.01098264E-01	3.18506050E-01	-5.68249802E-02

PATH LENGTH
(V/DELTA)

PATH LENGTH (V/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	5.17637E-01	7.68485E+03	9.07416E+03	1.24725E-05	4.59177E+01
1.00000E-01	5.18282E-01	9.81079E+03	1.16176E+04	9.05377E-06	3.33316E+01
2.00000E-01	5.18968E-01	1.11441E+04	1.38433E+04	7.54306E-06	2.77699E+01
3.00000E-01	5.19697E-01	1.18914E+04	1.58051E+04	6.71337E-06	2.47154E+01
4.00000E-01	5.20468E-01	1.24060E+04	1.75458E+04	6.15075E-06	2.26441E+01
5.00000E-01	5.21280E-01	1.27981E+04	1.90996E+04	5.73387E-06	2.11094E+01
6.00000E-01	5.22135E-01	1.31145E+04	2.04941E+04	5.40960E-06	1.99155E+01
7.00000E-01	5.23032E-01	1.33802E+04	2.17519E+04	5.14871E-06	1.89551E+01
8.00000E-01	5.23970E-01	1.36091E+04	2.28915E+04	4.93403E-06	1.81547E+01
9.00000E-01	5.24951E-01	1.38105E+04	2.39284E+04	4.75416E-06	1.75025E+01
1.00000E+00	5.25974E-01	1.39903E+04	2.48754E+04	4.60126E-06	1.69396E+01

QRYPC 2.03861193E+03 4.30579718E+03 QRYPL 1.49462160E+03 2.99531896E+03 QRYD-3.67489196E-02 QRY1 7.59384081E-02

PRATIO 8.62134348E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 3.45000000D-01 DELTA 3.83822177D-02
 IO(4) Q. IO(5) 5.90177295D-01
 I1(4)-3.15177143E-01 I1(5) 2.80200731E+00
 DDELDX 1.23283963E-03 DWDX-9.83923341E-01
 DIODX(5) 1.14110085E+00 DSMALRBDX 0.
 W 1.22698359D+00 IO(2) 3.58668624D+00 IO(3) 1.10739226D+00
 SMALRB 0. I1(2) 5.59185196E+00 I1(3) 2.71852841E+00
 RBX 1.00000000E+00 THETAB 1.22579633E+00 Q 1.00000000E+00
 DIODX(2) 9.32191547E+00 DIODX(3) 7.58782010E-01 DIODX(4) 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	8.15446080E-01	1.61233886E-01	1.64546675E-01	8.13976497E-02	0.
1.00000000E-01	8.16632686E-01	2.07104842E-01	2.14238935E-01	1.19159254E-01	-8.32216173E-03
2.00000000E-01	8.17951385E-01	2.47085484E-01	2.58933791E-01	1.53123285E-01	-1.58073883E-02
3.00000000E-01	8.19402175E-01	2.82196490E-01	2.99349013E-01	1.83835182E-01	-2.25758873E-02
4.00000000E-01	8.20985057E-01	3.13241542E-01	3.36071194E-01	2.11740704E-01	-2.87258979E-02
5.00000000E-01	8.22700031E-01	3.40861095E-01	3.69584408E-01	2.37207702E-01	-3.43384901E-02
6.00000000E-01	8.24547096E-01	3.65571109E-01	4.00291670E-01	2.60542432E-01	-3.94811582E-02
7.00000000E-01	8.26526254E-01	3.87791390E-01	4.28531219E-01	2.82001925E-01	-4.42105486E-02
8.00000000E-01	8.28637503E-01	4.07866614E-01	4.54589033E-01	3.01803497E-01	-4.85745551E-02
9.00000000E-01	8.30880845E-01	4.26082138E-01	4.78708543E-01	3.20132133E-01	-5.26139459E-02
1.00000000E+00	8.33256278E-01	4.42676024E-01	5.01098264E-01	3.37146288E-01	-5.63536422E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	
0.	5.07717E-01	7.61197E+03	8.93742E+03	1.24296E-05	4.57599E+01
1.00000E-01	5.08455E-01	9.69062E+03	1.14801E+04	9.01957E-06	3.32057E+01
2.00000E-01	5.09277E-01	1.10677E+04	1.36963E+04	7.48139E-06	2.75429E+01
3.00000E-01	5.10180E-01	1.18265E+04	1.56425E+04	6.65443E-06	2.44984E+01
4.00000E-01	5.11165E-01	1.23443E+04	1.73634E+04	6.09919E-06	2.24543E+01
5.00000E-01	5.12233E-01	1.27363E+04	1.88944E+04	5.69053E-06	2.09498E+01
6.00000E-01	5.13383E-01	1.30512E+04	2.02641E+04	5.37453E-06	1.97864E+01
7.00000E-01	5.14615E-01	1.33146E+04	2.14958E+04	5.12171E-06	1.88557E+01
8.00000E-01	5.15930E-01	1.35406E+04	2.26086E+04	4.91492E-06	1.80944E+01
9.00000E-01	5.17327E-01	1.37388E+04	2.36183E+04	4.74273E-06	1.74605E+01
1.00000E+00	5.18806E-01	1.39152E+04	2.45382E+04	4.59737E-06	1.69253E+01

QRYPC 1.93347694E+03 4.06878736E+03 QRYPL 1.43729404E+03 2.89813865E+03 QRYD-3.50591578E-02 QRY1 7.24625195E-02

PRATIO 8.45611528E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES			
X 3.65000000D-01	DELTA 3.84105437D-02	W 1.20735754D+00	10(2) 3.77096555D+00
IO(4) 0.	IO(5) 6.11975065D-01	SMALRB 0.	11(2) 5.89301938E+00
11(4)-3.29080709E-01	11(5) 2.95298178E+00	RBX 1.00000000E+00	THETAB 1.20579633E+00
DDLELX 1.62117929E-03	DMDX 9.78860316E-01	DIODX(2) 9.09717958E+00	DIODX(3) 7.81465146E-01
DIODX(5) 1.03362350E+00	DSMALRBDX 0.		DIODX(4) 0.
			10(3) 1.12280875D+00
			11(3) 2.91666171E+00
			Q 1.00000300E+00

DISTRIBUTION ACROSS SHOCK LAYER
ETA PDUM

0.0.	7.98874265E-01	1.58595126E-01	1.62284705E-01	8.59020248E-02	0.
1.00000000E-01	8.00217684E-01	2.04464204E-01	2.12411123E-01	1.25799767E-01	-8.26171935E-03
2.00000000E-01	8.01759425E-01	2.44276510E-01	2.57466778E-01	1.61661747E-01	-1.56876785E-02
3.00000000E-01	8.03499491E-01	2.79101612E-01	2.98184061E-01	1.94070088E-01	-2.23986152E-02
4.00000000E-01	8.05437880E-01	3.09778423E-01	3.35160796E-01	2.23501461E-01	-2.84930347E-02
5.00000000E-01	8.07574593E-01	3.36973013E-01	3.68887949E-01	2.50347791E-01	-3.40521695E-02
6.00000000E-01	8.09590628E-01	3.61220102E-01	3.99780936E-01	2.74939936E-01	-3.91435756E-02
7.00000000E-01	8.12442988E-01	3.82953304E-01	4.28177917E-01	2.97537714E-01	-4.38238998E-02
8.00000000E-01	8.15174671E-01	4.02527494E-01	4.54371083E-01	3.18385967E-01	-4.81409966E-02
9.00000000E-01	8.18104677E-01	4.20235572E-01	4.78607402E-01	3.37676681E-01	-5.2135701E-02
0.00000000E+00	8.21243007E-01	4.36321177E-01	5.01098264E-01	3.55578113E-01	-5.58424617E-02

PATH LENGTH (Y/Delta)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	4.97399E-01	7.53863E+03	8.79115E+03	1.23822E-05	4.55854E+01
1.00000E-01	4.98235E-01	9.55776E+03	1.13337E+04	8.98969E-06	3.30957E+01
2.00000E-01	4.99195E-01	1.09848E+04	1.35406E+04	7.41803E-06	2.73096E+01
3.00000E-01	5.00278E-01	1.17571E+04	1.54710E+04	6.59305E-06	2.42724E+01
4.00000E-01	5.01485E-01	1.27286E+04	1.71715E+04	6.04520E-06	2.22555E+01
5.00000E-01	5.02816E-01	1.26709E+04	1.86789E+04	5.64499E-06	2.07821E+01
6.00000E-01	5.04270E-01	1.29843E+04	2.00229E+04	5.33754E-06	1.96503E+01
7.00000E-01	5.05847E-01	1.32453E+04	2.12276E+04	5.09513E-06	1.87505E+01
8.00000E-01	5.07548E-01	1.34685E+04	2.23127E+04	4.89455E-06	1.80194E+01
9.00000E-01	5.09372E-01	1.36634E+04	2.32942E+04	4.73041E-06	1.74151E+01
1.00000E+00	5.11320E-01	1.38363E+04	2.41859E+04	4.59294E-06	1.69030E+01

QRYPC 1.82689583E+03 3.82984654E+03 QRYPL 1.36652744E+03 2.73399377E+03 QRYD-3.32145764E-02 QRY1 6.82700528E-02

PRATIO 8.28426680E-01 Q RATIO 0.

BODY AND SHOCK PROPERTIES

X 3.850000000-01 DELTA 3.84478132D-02 W 1.18785164D+00 IO(2) 3.95058555D+00 IO(3) 1.13863267D+00
 IO(4) 0. IO(5) 6.31564632D-01 SMALRB 0. RBX 0. THEI(2) 6.18944904E+00 I1(3) 3.12216303E+03
 I1(4)-3.41941134E-01 I1(5) 3.10152217E+00 DIODX(2) 8.84717003E+00 DIODX(3) 7.99192737E-01 DIODX(4) 0.
 DDELXD 2.13433967E-03 DMDX-9.71905056E-01 DIODX(1) 8.84717003E+00 DIODX(3) 7.99192737E-01 DIODX(4) 0.
 DIODX(5) 9.19365929E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	7.81765758E-01	1.55786043E-01	1.59866082E-01	9.03331500E-02	0.
1.00000000E-01	7.83270436E-01	2.01667414E-01	2.10460247E-01	1.32357734E-01	-8.19124293E-03
2.00000000E-01	7.85040306E-01	2.41315129E-01	2.55903698E-01	1.70104026E-01	-1.55485804E-02
3.00000000E-01	7.87075367E-01	2.75851082E-01	2.96944886E-01	2.04193705E-01	-2.21931873E-02
4.00000000E-01	7.89375618E-01	3.06151761E-01	3.34193951E-01	2.35133567E-01	-2.82238460E-02
5.00000000E-01	7.91941061E-01	3.32910466E-01	3.68153261E-01	2.63340889E-01	-3.37218903E-02
6.00000000E-01	7.94771696E-01	3.56681795E-01	3.99240201E-01	2.89162359E-01	-3.87548951E-02
7.00000000E-01	7.97867521E-01	3.77913949E-01	4.27804413E-01	3.12888398E-01	-4.33794679E-02
8.00000000E-01	8.01228538E-01	3.96972548E-01	4.54141005E-01	3.34764128E-01	-4.76433869E-02
9.00000000E-01	8.04854745E-01	4.14158414E-01	4.78500783E-01	3.54997875E-01	-5.15872579E-02
1.00000000E+00	8.08746144E-01	4.29721022E-01	5.01098264E-01	3.73767821E-01	-5.52458114E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	4.86746E-01	7.46508E+03	8.63544E+03	1.23311E-05	4.53972E+01
1.00000E-01	4.87683E-01	9.41176E+03	1.11787E+04	8.96551E-06	3.30067E+01
2.00000E-01	4.88785E-01	1.08958E+04	1.33764E+04	7.35304E-06	2.70704E+01
3.00000E-01	4.90052E-01	1.16829E+04	1.52908E+04	6.52970E-06	2.40392E+01
4.00000E-01	4.91485E-01	1.22089E+04	1.69704E+04	5.98917E-06	2.20492E+01
5.00000E-01	4.93082E-01	1.26017E+04	1.84537E+04	5.59754E-06	2.06074E+01
6.00000E-01	4.94844E-01	1.29138E+04	1.97714E+04	5.29887E-06	1.95079E+01
7.00000E-01	4.96772E-01	1.31725E+04	2.09483E+04	5.06311E-06	1.86399E+01
8.00000E-01	4.98864E-01	1.33928E+04	2.20047E+04	4.87303E-06	1.79401E+01
9.00000E-01	5.01122E-01	1.35844E+04	2.29574E+04	4.71721E-06	1.73665E+01
1.00000E+00	5.03545E-01	1.37539E+04	2.38200E+04	4.58795E-06	1.68906E+01

QRYPC 1.71978072E+03 3.59092753E+03 QRYPL 1.24597723E+03 2.57890352E+03 QRYD-3.08466449E-02 QRY1 6.41719895E-02

PRATIO 8.10685285E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.05000000D-01 DELTA 3.84969668D-02 W 1.168511140D+00 IO(2) 4.12490716D+00 IO(3) 1.15475665D+00
 IO(4) 0. IO(5) 6.48815079D-01 SMALRB 0. SMALRB 0. I1(2) 6.48039992E+00 I1(3) 3.33404295E+00
 I1(4)-3.53513781E-01 I1(5) 3.24731715E+00 RBX 1.00000000E+00 THETAB 1.16579633E+00 Q 1.00000000E+00
 DDELDX 2.81960229E-03 DWDX-9.62284164E-01 DIODX(2) 8.56689142E+00 DIODX(3) 8.11019931E-01 DIODX(4) 0.
 DIJDX(5) 7.98494991E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA PDUM STAENT CAPH AUDUM V

0.	7.64257570E-01	1.52810924E-01	1.57292044E-01	9.46691036E-02	0.
1.00000000E-01	7.65926252E-01	1.98720843E-01	2.08387654E-01	1.38808838E-01	-8.10726551E-03
2.00000000E-01	7.67926781E-01	2.38209956E-01	2.54245875E-01	1.78424173E-01	-1.53835223E-02
3.00000000E-01	7.70258329E-01	2.72455945E-01	2.95632711E-01	2.14176833E-01	-2.19503109E-02
4.00000000E-01	7.72921170E-01	3.02375208E-01	3.33171733E-01	2.46605499E-01	-2.79065725E-02
5.00000000E-01	7.75915307E-01	3.28689867E-01	3.67375711E-01	2.76153136E-01	-3.33336676E-02
6.00000000E-01	7.79240737E-01	3.51975486E-01	3.98670181E-01	3.03187349E-01	-3.82991154E-02
7.00000000E-01	7.82897462E-01	3.72695605E-01	4.27411238E-01	3.28015757E-01	-4.28594167E-02
8.00000000E-01	7.86885481E-01	3.91227103E-01	4.53899142E-01	3.50897743E-01	-4.70522136E-02
9.00000000E-01	7.91204794E-01	4.07879081E-01	4.78388854E-01	3.72053561E-01	-5.09479603E-02
1.00000000E+00	7.95855402E-01	4.22907089E-01	5.01098264E-01	3.91671436E-01	-5.45512291E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	4.75845E-01	7.39147E+03	8.47052E+03	1.22778E-05	4.52009E+01
1.00000E-01	4.76885E-01	9.25095E+03	1.10154E+04	8.95059E-06	3.29518E+01
2.00000E-01	4.78130E-01	1.07987E+04	1.32043E+04	7.28932E-06	2.68358E+01
3.00000E-01	4.79582E-01	1.16041E+04	1.51026E+04	6.46509E-06	2.38013E+01
4.00000E-01	4.81240E-01	1.21353E+04	1.67611E+04	5.93163E-06	2.18374E+01
5.00000E-01	4.83104E-01	1.25290E+04	1.82197E+04	5.54861E-06	2.04273E+01
6.00000E-01	4.85174E-01	1.28399E+04	1.95105E+04	5.25884E-06	1.93605E+01
7.00000E-01	4.87451E-01	1.30964E+04	2.06590E+04	5.03190E-06	1.85250E+01
8.00000E-01	4.89934E-01	1.33138E+04	2.16863E+04	4.85049E-06	1.78572E+01
9.00000E-01	4.92623E-01	1.35023E+04	2.26093E+04	4.70321E-06	1.73150E+01
1.00000E+00	4.95519E-01	1.36683E+04	2.34423E+04	4.58237E-06	1.68701E+01

QRYPC 1.61294972E+03 3.35399937E+03 QRYPL 1.19247283E+03 2.45743993E+03 QRYO-2.91790074E-02 QRY1 6.04443814E-02

PRATIO 7.92529424E-01 GRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.25000000-01 DELTA 3.85620747D-02 W 1.14940119D+00 IO(2) 4.29330288D+00 IO(3) 1.17105211D+00
 IO(4) 0. IO(5) 6.63603402D-01 SMALRB 0. I1(2) 6.76490294E+00 I1(3) 3.55104133E+00
 I1(4)-3.63453128E-01 I1(5) 3.38988112E+00 RBX 1.00000000E+00 THETAB 1.14579632E+00 Q 1.00000000E+00
 DDELDX 3.74389426E-03 DWDX-9.48876301E-01 DIODX(2) 8.24974069E+00 DIODX(3) 8.15721967E-01 DIODX(4) 0.
 DIJDX(5) 6.71532352E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER ETA PDUM

	STAENT	CAPH	AUDUM	V
0.	1.49678628E-01	1.54567106E-01	9.88784978E-02	0.
1.00000000E-01	1.95635603E-01	2.06197297E-01	1.45118269E-01	-8.00475937E-03
2.00000000E-01	2.34974673E-01	2.52496693E-01	1.86583803E-01	-1.51830308E-02
3.00000000E-01	2.68932746E-01	2.94250367E-01	2.23978210E-01	-2.16565323E-02
4.00000000E-01	2.98468419E-01	3.32096450E-01	2.57872995E-01	-2.75241997E-02
5.00000000E-01	3.24334175E-01	3.66558969E-01	2.88737474E-01	-3.28672783E-02
6.00000000E-01	3.47127588E-01	3.98072260E-01	3.16960638E-01	-3.77531078E-02
7.00000000E-01	3.67328242E-01	4.26999372E-01	3.42867632E-01	-4.22379755E-02
8.00000000E-01	3.85324755E-01	4.53644611E-01	3.66732336E-01	-4.63592939E-02
9.00000000E-01	4.01434826E-01	4.78271908E-01	3.88787089E-01	-5.01872839E-02
1.00000000E+00	4.15920299E-01	5.01098264E-01	4.09230273E-01	-5.37262886E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

PATH LENGTH (Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	4.64814E-01	7.31815E+03	8.29690E+03	1.22241E-05	4.50031E+01
1.00000E-01	4.65956E-01	9.07777E+03	1.08444E+04	8.94486E-06	3.29307E+01
2.00000E-01	4.67344E-01	1.06941E+04	1.30250E+04	7.22746E-06	2.66080E+01
3.00000E-01	4.68977E-01	1.15208E+04	1.49073E+04	6.40026E-06	2.35627E+01
4.00000E-01	4.70856E-01	1.20582E+04	1.65445E+04	5.87345E-06	2.16232E+01
5.00000E-01	4.72981E-01	1.24531E+04	1.79783E+04	5.49889E-06	2.02443E+01
6.00000E-01	4.75351E-01	1.27630E+04	1.92418E+04	5.21798E-06	1.92101E+01
7.00000E-01	4.77967E-01	1.30173E+04	2.03615E+04	4.99988E-06	1.84072E+01
8.00000E-01	4.80829E-01	1.32320E+04	2.13591E+04	4.82720E-06	1.77714E+01
9.00000E-01	4.83937E-01	1.34172E+04	2.2521E+04	4.68853F-06	1.72609E+01
1.00000E+00	4.87290E-01	1.35798E+04	2.30550E+04	4.57621E-06	1.68474E+01

QRYPC 1.50745626E+03 3.12133637E+03 QRYPL 1.12544247E+03 2.29537486E+03 QRYO-2.73845991E-02 QRY1 5.63388419E-02

PRATIO 7.74155776E-01 GRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.4500000D-01 DELTA 3.86488130D-02 W 1.13061277D+00 IO(2) 4.45496519D+00 IO(3) 1.18736282D+00
 IO(4) 0. IO(5) 6.75824310D-01 SMALRB 0. I1(2) 7.04166109E+00 I1(3) 3.77151139E+00
 I1(4) 3.71264459E-01 I1(5) 3.52856415E+00 RBX 1.00000000E+00 THETAB 1.12579633E+00 Q 1.00000000E+00
 DDELDX 5.00263317E-03 DWDX-9.30046259E-01 DIODX(2) 7.88711962E+00 DIODX(3) 8.11710373E-01 DIODX(4) 0.
 DIODX(5) 5.39678756E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER
ETA

	ETA	STAENT	CAPH	AUDUM	V
0.	7.2887914E-01	1.46405521E-01	1.51701367E-01	1.02915945E-01	0.
1.0000000E-01	7.30877124E-01	1.92430359E-01	2.03897489E-01	1.51235653E-01	-7.87639427E-03
2.0000000E-01	7.3327078E-01	2.31630841E-01	2.50662909E-01	1.94527977E-01	-1.49332958E-02
3.0000000E-01	7.36229002E-01	2.65306418E-01	2.92803266E-01	2.33538725E-01	-2.12922753E-02
4.0000000E-01	7.39582898E-01	2.94460067E-01	3.30972354E-01	2.68873134E-01	-2.70519903E-02
5.0000000E-01	7.43388764E-01	3.19876074E-01	3.65706283E-01	3.01027502E-01	-3.22933398E-02
6.0000000E-01	7.47646600E-01	3.42174981E-01	3.97448823E-01	3.30412640E-01	-3.70832888E-02
7.0000000E-01	7.52356408E-01	3.61853057E-01	4.26570461E-01	3.57371521E-01	-4.14777438E-02
8.0000000E-01	7.57518186E-01	3.79311084E-01	4.53382930E-01	3.82192726E-01	-4.55237451E-02
9.0000000E-01	7.63131935E-01	3.94875641E-01	4.78150410E-01	4.05120817E-01	-4.92611576E-02
1.0000000E+00	7.69197655E-01	4.08815046E-01	5.01098264E-01	4.26364418E-01	-5.27239886E-02

PATH LENGTH (Y/DELTA)

	PATH LENGTH (Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(IND)
0.	4.53818E-01	7.24558E+03	8.11546E+03	1.21726E-05	4.48136E+01	
1.00000E-01	4.55062E-01	8.89247E+03	1.06667E+04	8.95254E-06	3.29590E+01	
2.00000E-01	4.56587E-01	1.05837E+04	1.28396E+04	7.16777E-06	2.63883E+01	
3.00000E-01	4.58394E-01	1.14333E+04	1.47063E+04	6.33676E-06	2.33289E+01	
4.00000E-01	4.60482E-01	1.19779E+04	1.63223E+04	5.81587E-06	2.14112E+01	
5.00000E-01	4.62852E-01	1.23745E+04	1.77312E+04	5.44940E-06	2.00621E+01	
6.00000E-01	4.65503E-01	1.26836E+04	1.89672E+04	5.17713E-06	1.90597E+01	
7.00000E-01	4.68436E-01	1.29359E+04	2.00580E+04	4.96768E-06	1.82886E+01	
8.00000E-01	4.71649E-01	1.31478E+04	2.10257E+04	4.80358E-06	1.76845E+01	
9.00000E-01	4.75145E-01	1.33298E+04	2.18885E+04	4.67340E-06	1.72052E+01	
1.00000E+00	4.78921E-01	1.34890E+04	2.26612E+04	4.56948E-06	1.68226E+01	

QRYPC 1.40448454E+03 2.895444386E+03 QRYPL 1.07954983E+03 2.13901709E+03 QRYD-2.58362710E-02 QRY1 5.23630830E-02

PRATIO 7.55842256E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.6500000D-01 DELTA 3.87651554D-02 W 1.112277749D+00 IO(2) 4.60888871D+00 IO(3) 1.20349638D+00
 IO(4) 0. IO(5) 6.85406289D-01 SMALRB 0. RBX 1.00000000E+00 THETAB 7.30890622E+00 I1(2) 7.30890622E+00 I1(3) 3.99325074E+00
 I1(4) -3.76234022E-01 I1(5) 3.66248022E+00 DIODX(12) 7.46825194E+00 DIODX(3) 7.96977235E-01 DIODX(4) 0.
 DDELXD 6.73250402E-03 DWDX-9.03395525E-01 DIODX(1) 0.03395525E-01 DIODX(2) 7.46825194E+00 DIODX(3) 7.96977235E-01 DIODX(4) 0.
 DIODX(5) 4.05452401E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER ETA

	ETA	POUM	STAENT	CAPH	AUDUM	V
0.	7.11661651E-01	1.43019918E-01	1.48714003E-01	1.06715365E-01	0.	
1.0000000E-01	7.13817727E-01	1.89135550E-01	2.0150337E-01	1.57087576E-01	-7.71146688E-03	
2.0000000E-01	7.16472709E-01	2.28212100E-01	2.48756630E-01	2.02176869E-01	-1.46141735E-02	
3.0000000E-01	7.19626597E-01	2.61614589E-01	2.91300859E-01	2.42772925E-01	-2.08290118E-02	
4.0000000E-01	7.23279391E-01	2.90392325E-01	3.29806689E-01	2.79515506E-01	-2.64539229E-02	
5.0000000E-01	7.27431092E-01	3.15362664E-01	3.64823068E-01	3.12928425E-01	-3.15690968E-02	
6.0000000E-01	7.32081699E-01	3.37169944E-01	3.96803763E-01	3.43444669E-01	-3.62408196E-02	
7.0000000E-01	7.37231212E-01	3.56327655E-01	4.26127134E-01	3.71425272E-01	-4.05243620E-02	
8.0000000E-01	7.42879631E-01	3.73249091E-01	4.53111170E-01	3.97173663E-01	-4.44661757E-02	
9.0000000E-01	7.49026957E-01	3.88269931E-01	4.78025073E-01	4.20946716E-01	-4.81055853E-02	
1.0000000E+00	7.55673189E-01	4.01665107E-01	5.01098264E-01	4.42963346E-01	-5.14761047E-02	

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

	PATH LENGTH (Y/DELTA)	PRESSURE (ATM)	TEMPERATURE (DEG K)	ENTHALPY (CAL/GM)	DENSITY (GM/CC)	DENSITY(ND)
0.	4.43098E-01	7.17448E+03	7.92780E+03	1.21271E-05	4.46463E+01	
1.00000E-01	4.44440E-01	8.70132E+03	1.04840E+04	8.97317E-06	3.30349E+01	
2.00000E-01	4.46093E-01	1.04654E+04	1.26501E+04	7.11575E-06	2.61968E+01	
3.00000E-01	4.48057E-01	1.13425E+04	1.45017E+04	6.27687E-06	2.31084E+01	
4.00000E-01	4.50331E-01	1.18952E+04	1.60969E+04	5.76080E-06	2.12085E+01	
5.00000E-01	4.52916E-01	1.22939E+04	1.74810E+04	5.40174E-06	1.98866E+01	
6.00000E-01	4.55812E-01	1.26025E+04	1.86898E+04	5.13755E-06	1.89140E+01	
7.00000E-01	4.59018E-01	1.28529E+04	1.97517E+04	4.93628E-06	1.81730E+01	
8.00000E-01	4.62535E-01	1.30621E+04	2.06997E+04	4.78032E-06	1.75988E+01	
9.00000E-01	4.66363E-01	1.32410E+04	2.15223E+04	4.65819E-06	1.71492E+01	
1.00000E+00	4.70501E-01	1.33967E+04	2.22649E+04	4.5623E-06	1.67960E+01	

QRYPC 1.30513097E+03 2.67905321E+03 QRYPL 9.87257146E+02 1.98451536E+03 QRYG-2.38429715E-02 QRYV 4.85054568E-02

PRATIO 7.37987847E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 4.85000000D-01 DELTA 3.89223753D-02 IO(3) 1.21921299D+00
 IO(4) 0. IO(5) 6.92335272D-01 I1(2) 7.56419870E+00 I1(3) 4.21326137E+00
 I1(4)-3.77332056E-01 I1(5) 3.79040084E+00 RBX 0. SMALRB 0. THETAB 1.08579633E+00 Q 1.00000000E+00
 DDELDX 9.12940781E-03 DWDX-8.65653706E-01 DIODX(2) 6.97639634E+00 DIODX(3) 7.68681739E-01 DIODX(4) 0.
 DIODX(5) 2.71769150E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUW	STAENT	CAPH	AUDUM	V
0.	6.95423757E-01	1.39568052E-01	1.45638222E-01	1.10183209E-01	0.
1.00000000E-01	6.97726928E-01	1.85799025E-01	1.99041497E-01	1.62569302E-01	-7.49441750E-03
2.00000000E-01	7.00559019E-01	2.24769768E-01	2.46798131E-01	2.09416306E-01	-1.41964062E-02
3.00000000E-01	7.03920029E-01	2.57913329E-01	2.89758732E-01	2.51558628E-01	-2.02253375E-02
4.00000000E-01	7.07809958E-01	2.86326886E-01	3.28611231E-01	2.89671095E-01	-2.56777530E-02
5.00000000E-01	7.12228806E-01	3.10861832E-01	3.63917994E-01	3.24305363E-01	-3.06325730E-02
6.00000000E-01	7.17176574E-01	3.32186906E-01	3.96143223E-01	3.55916792E-01	-3.51549420E-02
7.00000000E-01	7.22653260E-01	3.50833198E-01	4.25673347E-01	3.84884578E-01	-3.92991084E-02
8.00000000E-01	7.28658866E-01	3.67226743E-01	4.52833258E-01	4.11527041E-01	-4.31106111E-02
9.00000000E-01	7.35193391E-01	3.81712459E-01	4.77896977E-01	4.36113366E-01	-4.66279604E-02
1.00000000E+00	7.42256835E-01	3.94571196E-01	5.01098264E-01	4.58872734E-01	-4.98839429E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(CM/CC)	DENSITY(ND)
0.	4.32988E-01	7.10502E+03	7.73645E+03	1.20967E-05	4.45344E+01
1.00000E-01	4.34422E-01	8.51144E+03	1.02991E+04	9.00787E-06	3.31626E+01
2.00000E-01	4.36185E-01	1.03430E+04	1.24593E+04	7.07306E-06	2.60396E+01
3.00000E-01	4.38278E-01	1.12495E+04	1.42965E+04	6.22384E-06	2.29133E+01
4.00000E-01	4.40700E-01	1.18115E+04	1.58715E+04	5.71099E-06	2.10251E+01
5.00000E-01	4.43451E-01	1.22128E+04	1.72315E+04	5.35820E-06	1.97263E+01
6.00000E-01	4.46532E-01	1.25210E+04	1.84136E+04	5.10112E-06	1.87799E+01
7.00000E-01	4.49942E-01	1.27696E+04	1.94472E+04	4.90712E-06	1.80657E+01
8.00000E-01	4.53681E-01	1.29761E+04	2.03559E+04	4.75840E-06	1.75182E+01
9.00000E-01	4.57749E-01	1.31518E+04	2.11589E+04	4.64344E-06	1.70949E+01
1.00000E+00	4.62147E-01	1.33040E+04	2.18717E+04	4.55458E-06	1.67678E+01

QRYPC 1.21090712E+03 2.47546848E+03 QRYPL 9.18319258E+02 1.85042460E+03 QRYU-2.21459375E-02 QRY1 4.49933172E-02

PRATIO 7.21149271E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 5.05000000D-01 DELTA 3.91364632D-02 W 1.07779909D+00 IO(2) 4.88808253D+00 IO(3) 1.23421220D+00
 IO(4) 0. IO(5) 6.96691581D-01 SMALRB 0. SMALRB 0. IO(2) 7.80415126E+00 IO(3) 4.42741643E+00
 II(4)-3.73085561E-01 II(5) 3.91064665E+00 RBX 1.00000000E+00 THETAB 1.06579633E+00 Q 1.00000000E+00
 DDDELX 1.24731112E-02 DWDX-8.11474025E-01 DIODX(2) 6.40215275E+00 DIODX(3) 7.24589699E-01 DIODX(4) 0.
 DIODX(5) 1.49827530E-01 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER
ETA PDUM

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	6.80983442E-01	1.36123853E-01	1.42528660E-01	1.13179071E-01	0.
1.00000000E-01	6.83414379E-01	1.82495489E-01	1.96553694E-01	1.67524711E-01	-7.20285583E-03
2.00000000E-01	6.86376909E-01	2.21382260E-01	2.44819971E-01	2.16077369E-01	-1.36379220E-02
3.00000000E-01	6.89871030E-01	2.54286719E-01	2.88201633E-01	2.59716431E-01	-1.94217507E-02
4.00000000E-01	6.93896744E-01	2.82354772E-01	3.27404664E-01	2.99151866E-01	-2.46484395E-02
5.00000000E-01	6.98454050E-01	3.06472337E-01	3.63004520E-01	3.34963150E-01	-2.93947911E-02
6.00000000E-01	7.03542948E-01	3.27332824E-01	3.95476629E-01	3.67627928E-01	-3.37241115E-02
7.00000000E-01	7.09163438E-01	3.45485065E-01	4.25215693E-01	3.97543445E-01	-3.76890505E-02
8.00000000E-01	7.15315520E-01	3.61367901E-01	4.52552820E-01	4.25042773E-01	-4.13337531E-02
9.00000000E-01	7.21999195E-01	3.75335511E-01	4.77767712E-01	4.50407274E-01	-4.46955102E-02
1.00000000E+00	7.29214461E-01	3.87676203E-01	5.01098264E-01	4.73876255E-01	-4.78060391E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

(Y/DELTA) (ATM) (DEG K) (CAL/GM) (GM/CC)

0.	4.23597E-01	7.03909E+03	7.54554E+03	1.20893E-05	4.45072E+01
1.00000E-01	4.25511E-01	8.33245E+03	1.01160E+04	9.05819E-06	3.33479E+01
2.00000E-01	4.27355E-01	1.02170E+04	1.22715E+04	7.04753E-06	2.59456E+01
3.00000E-01	4.29331E-01	1.11561E+04	1.40955E+04	6.18336E-06	2.27641E+01
4.00000E-01	4.32037E-01	1.17289E+04	1.56513E+04	5.67078E-06	2.08771E+01
5.00000E-01	4.34875E-01	1.21332E+04	1.69882E+04	5.32242E-06	1.95946E+01
6.00000E-01	4.38043E-01	1.24412E+04	1.81445E+04	5.07081E-06	1.86683E+01
7.00000E-01	4.41543E-01	1.26879E+04	1.91507E+04	4.88250E-06	1.79750E+01
8.00000E-01	4.45373E-01	1.28918E+04	2.00311E+04	4.73947E-06	1.74484E+01
9.00000E-01	4.49534E-01	1.30642E+04	2.08054E+04	4.63009E-06	1.70458E+01
1.00000E+00	4.54027E-01	1.32129E+04	2.14894E+04	4.54668E-06	1.67387E+01

QRYPC 1.12357610E+03 2.28858892E+03 QRYPL 8.64145351E+02 1.74991564E+03 QRYD-2.06741544E-02 QRY1 4.20042089E-02

PRATIO 7.06174772E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES

X 5.25000000-01 DELTA 3.94301327D-02 W 1.06229841D+00 IO(2) 5.00956305D+00 IO(3) 1.24810969D+00
 IO(4) 0. IO(5) 6.98659106D-01 SMALRB 0. I1(2) 8.02412690E+00 I1(3) 4.63007942E+00
 I1(4) -3.61449890E-01 I1(5) 4.02087606E+00 RBX 1.00000000E+00 THETAB 1.04579633E+00 Q 1.00000000E+00
 DDELDX 1.71543230E-02 DWDX -7.33344428E-01 DIODX(2) 5.74032168E+00 DIODX(3) 6.63026725E-01 DIODX(4) 0.
 DIODX(5) 5.85946633E-02 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER
ETA

	ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	6.69487776E-01	1.32794560E-01	1.39465079E-01	1.15503409E-01	0.	
1.00000000E-01	6.72015356E-01	1.79333004E-01	1.94102246E-01	1.71732837E-01	-6.80565932E-03	
2.00000000E-01	6.75035068E-01	2.18162474E-01	2.42870088E-01	2.21921893E-01	-1.28802257E-02	
3.00000000E-01	6.78546914E-01	2.50855084E-01	2.86666152E-01	2.66994282E-01	-1.83355106E-02	
4.00000000E-01	6.82550893E-01	2.78605352E-01	3.26213857E-01	3.07694504E-01	-2.32616117E-02	
5.00000000E-01	6.87047005E-01	3.02333556E-01	3.62102765E-01	3.44629302E-01	-2.77319693E-02	
6.00000000E-01	6.92035250E-01	3.22757596E-01	3.94818172E-01	3.78298116E-01	-3.18070326E-02	
7.00000000E-01	6.97515628E-01	3.40443876E-01	4.24763185E-01	4.09115800E-01	-3.55370129E-02	
8.00000000E-01	7.03488140E-01	3.55843901E-01	4.52275411E-01	4.37429799E-01	-3.89638629E-02	
9.00000000E-01	7.09952784E-01	3.69320989E-01	4.77639744E-01	4.63533311E-01	-4.21233691E-02	
1.00000000E+00	7.16909562E-01	3.81170039E-01	5.01098264E-01	4.87675470E-01	-4.50453855E-02	

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(ND)

	(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(ND)
0.	4.16839E-01	6.97862E+03	7.36099E+03	1.21196E-05	4.46184E+01	
1.00000E-01	4.18413E-01	8.17373E+03	9.94068E+03	9.12920E-06	3.36093E+01	
2.00000E-01	4.20293E-01	1.00926E+04	1.20931E+04	7.04683E-06	2.59431E+01	
3.00000E-01	4.22480E-01	1.10671E+04	1.39053E+04	6.16149E-06	2.26837E+01	
4.00000E-01	4.24973E-01	1.16508E+04	1.54435E+04	5.64637E-06	2.07872E+01	
5.00000E-01	4.27772E-01	1.20582E+04	1.67588E+04	5.29966E-06	1.95108E+01	
6.00000E-01	4.30878E-01	1.23660E+04	1.78909E+04	5.05092E-06	1.85951E+01	
7.00000E-01	4.34290E-01	1.26109E+04	1.88713E+04	4.86576E-06	1.79134E+01	
8.00000E-01	4.38009E-01	1.28119E+04	1.97249E+04	4.7258E-06	1.73983E+01	
9.00000E-01	4.42034E-01	1.29809E+04	2.04720E+04	4.61946E-06	1.70066E+01	
1.00000E+00	4.46365E-01	1.31258E+04	2.11288E+04	4.53883E-06	1.67098E+01	

QRYPC 1.04563781E+03 2.12329269E+03 QRYPL 7.97019876E+02 1.62911928E+03 QRYD-1.91653562E-02 QRY1 3.90285795E-02

PRATIO 6.94253851E-01 QRATIO 0.

BODY AND SHOCK PROPERTIES
 X 5.4500000D-01 DELTA 3.98354290D-02 W 1.04857618D+00 IO(2) 5.11508695D+00 IO(3) 1.26039236D+00
 IO(4) 0. IO(5) 6.98426416D-01 SMALRB 0. I1(2) 8.21805264E+00 I1(3) 4.81383353E+00
 I1(4)-3.39766606E-01 I1(5) 4.11805191E+00 RBX 1.00000000E+00 THETAB 1.02579633E+00 Q 1.00000000E+00
 DDELDX 2.36913975E-02 DWDX-6.15840400E-01 DIODX(2) 5.09095087E+00 DIODX(3) 5.94659155E-01 DIODX(4) 0.
 DI3DX(5) 7.52600434E-02 DSMALRBDX 0.

DISTRIBUTION ACROSS SHOCK LAYER

ETA	PDUM	STAENT	CAPH	AUDUM	V
0.	6.62921901E-01	1.29720691E-01	1.36542433E-01	1.16805322E-01	0.
1.00000000E-01	6.65492902E-01	1.76460701E-01	1.91763211E-01	1.74830775E-01	-6.26253618E-03
2.00000000E-01	6.68445812E-01	2.15270208E-01	2.41009173E-01	2.26577949E-01	-1.18474741E-02
3.00000000E-01	6.71780633E-01	2.47789950E-01	2.85200252E-01	2.73013502E-01	-1.68591425E-02
4.00000000E-01	6.75497365E-01	2.75262328E-01	3.25076745E-01	3.14915331E-01	-2.13814978E-02
5.00000000E-01	6.79596007E-01	2.98641406E-01	3.61241124E-01	3.52916505E-01	-2.54828657E-02
6.00000000E-01	6.84076560E-01	3.18669143E-01	3.94188676E-01	3.87537470E-01	-2.92194164E-02
7.00000000E-01	6.88939023E-01	3.35929197E-01	4.24330331E-01	4.19210027E-01	-3.26377530E-02
8.00000000E-01	6.94183397E-01	3.50885498E-01	4.52009887E-01	4.48295433E-01	-3.57768652E-02
9.00000000E-01	6.99809681E-01	3.63910337E-01	4.77517178E-01	4.75098244E-01	-3.86696229E-02
1.00000000E+00	7.05817876E-01	3.75305087E-01	5.01098264E-01	4.99877019E-01	-4.13439315E-02

PATH LENGTH PRESSURE TEMPERATURE ENTHALPY DENSITY DENSITY(IND)

(Y/DELTA)	(ATM)	(DEG K)	(CAL/GM)	(GM/CC)	DENSITY(IND)
0.	4.12751E-01	6.92605E+03	7.19060E+03	1.22174E-05	4.49786E+01
1.00000E-01	4.14352E-01	8.04225E+03	9.78147E+03	9.23889E-06	3.40132E+01
2.00000E-01	4.16191E-01	9.97715E+03	1.19327E+04	7.08611E-06	2.60877E+01
3.00000E-01	4.18267E-01	1.09876E+04	1.37353E+04	6.17184E-06	2.27217E+01
4.00000E-01	4.20581E-01	1.15821E+04	1.52582E+04	5.64898E-06	2.07968E+01
5.00000E-01	4.23133E-01	1.19925E+04	1.65541E+04	5.29938E-06	1.95098E+01
6.00000E-01	4.25923E-01	1.23000E+04	1.76643E+04	5.04919E-06	1.85887E+01
7.00000E-01	4.28950E-01	1.25428E+04	1.86210E+04	4.86290E-06	1.79029E+01
8.00000E-01	4.32216E-01	1.27406E+04	1.94501E+04	4.72180E-06	1.73834E+01
9.00000E-01	4.35719E-01	1.29057E+04	2.01721E+04	4.61392E-06	1.69862E+01
1.00000E+00	4.39459E-01	1.30462E+04	2.08037E+04	4.53142E-06	1.66825E+01

QRYPC 9.80357692E+02 1.98595243E+03 QRYPL 7.55742156E+02 1.52720737E+03 QRYD-1.80570554E-02 QRY1 3.65401340E-02

PRATIO 6.87445088E-01 QRATIO 0.

RHO IS SMALLER THAN ALLOWED

Error Diagnostics

The following table gives the error diagnostics as the message and the corresponding subprogram which prints the message:

Message	Diagnosis	Subprogram
ICODE =, iteration did not converge	Nonfatal	MAIN
Iteration limit in RANH program stopped	Fatal	RANH
RHO is smaller than allowed	Nonfatal	{ THEP THER
RHO is larger than allowed	{ Fatal Nonfatal	{ THEP THER
H is zero or negative	Nonfatal	{ THEP THER
H is larger than allowed	Nonfatal	{ THEP THER
Iteration limit reached in PROPIT	Nonfatal	PROFIT
FEMP BLEW	Fatal	RADFLUX
N-R did not converge TBJA =	Nonfatal	FEMP
T did not converge TGUS =, DIG =, LK =	Nonfatal	FEMP

Langley Research Center,
National Aeronautics and Space Administration,
Hampton, Va., July 13, 1971.

APPENDIX A

SUBROUTINE INT1

Language: FORTRAN

Purpose: To solve a set of ordinary differential equations.

Use: CALL INT1 (II,N,NT,CI,SPEC,CIMAX,IERR,VAR,CUVAR,DER,ELE1,ELE2,ELT,ERRVAL,DERSUB,CHSUB,ITEXT)

II INT1 is a closed subroutine composed of an initialization section and an integration section. The user is required to enter the initialization section before he starts his first integration step. The above calling sequence is used for both initialization and integration, with the value of the code word II determining which of the two sections of INT1 will be entered.

The user must set II = 0 in order to initialize.

During initialization the derivatives will be evaluated by using the initial values of the variables, but no integration will occur and control will be returned to the calling program. When INT1 is called with II > 0, entry is made to the integration section. Upon each entry to INT1, the subroutine stores a 1 in II so that the user need not supply a value of II > 0 for repetitive integration.

Besides serving as a means for specifying the entry point to INT1 from the calling program, II can also be set to specified values in CHSUB:

- 2 The user will store the integer 2 in II if the answers in CHSUB are not acceptable to him and he wishes to recompute the answers using a shorter interval. This shorter interval must be stored by the user in CI. It must be smaller than the computing interval just used.
- 3 The user will store the integer 3 in II if he wishes to return to the calling program. The answers for the interval are considered acceptable to the user and will be transferred to the VAR array (explained below) by INT1.

In DERSUB, II may be set to:

- 4 The user will store the integer 4 in II if he wishes to discontinue calculation of the present interval and return to the calling

APPENDIX A

program. On return to the calling program, the answers at the beginning of the interval will still be in the VAR array.

If the user does not set II to a value in either CHSUB or DERSUB, II will always be 1 upon the return to the calling program.

- N An integer value supplied by the user which is the number of differential equations to be solved. INT1 is compiled to solve a maximum of 20 equations but may be recompiled for larger values of N if necessary.
- NT An integer value supplied by the user which is the number of values in the ELT block described later in this writeup. INT1 is compiled with a maximum of 10 values in the ELT block but may be recompiled for more values if necessary.
- CI A floating-point value supplied by the user which is the computing interval that INT1 will use initially. CI must be a signed value – positive if integrating forward, negative if integrating backward. Upon entry to CHSUB, CI will contain the computing interval that INT1 will use for the next step unless it has to take a short interval to hit an ELT value or a SPEC value described below. The computing interval used on the present step is available in CHSUB as the algebraic difference between CUVAR (1) and VAR (1). Since the subroutine is used on a binary computer and the interval variation is a halving and doubling process, CI should be a power of 2.
- SPEC A floating-point value supplied by the user which specifies how often he wishes INT1 to return control to the calling program so that the user may print his results.
SPEC = 0.0: Control will be returned after every acceptable integration step.
SPEC > 0.0: SPEC is the absolute value of the specified increment of the independent variable for which the user desires control returned to the calling program.
The first printout is made at the initial value of the independent variable. The next return is at the nonzero integer multiple of SPEC closest to the initial value of the independent variable. The remaining returns occur at values which have been updated from this point by the increment given in SPEC. The return times generated by the increment given in SPEC are not altered by an intervening return due to an ELT value (explained subsequently in "ELT").
- CIMAX A floating-point value supplied by the user which is the absolute value of the maximum computing interval that will be used. This value will

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be used if the doubling process would extend the computing interval to a value larger than C1MAX. C1MAX should be set to 0.0 if there is no desired maximum.

IERR An integer value supplied by INT1 as an error code. It must be checked at every return to the calling program. It may have the following values:

- 1 A normal return, no error.
- 2 The ELT block is not monotonic in the direction of integration.
- 3 The variables have failed to meet the local-truncation-error requirements nine consecutive times. The answers at the beginning of the interval are still in the VAR array.
- 4 The variables have failed to meet the local-truncation-error requirements at least nine times over the last three intervals. An acceptable answer has been reached, however, and is in the VAR array.

VAR A double-precision one-dimensional array containing the independent variable followed by the N dependent variables. The user must store the N+1 initial values (in the double-precision mode) in the array for initialization. INT1 will store the new values of the variables in VAR after each integration step when they are accepted by the user in CHSUB. The elements of the VAR block can be printed out in the calling program in accordance with the user's specification in SPEC.

CUVAR A double-precision one-dimensional array which is given values by INT1 for two purposes. INT1 will store in the same order as the VAR array the values of the independent variable and N dependent variables at which the derivatives are to be evaluated in the DERSUB subroutine. Although CUVAR must be in a double-precision array in INT1 to maintain the "partial double-precision mode" of computation, the evaluation of the derivatives should be in single precision. Two suggested ways of doing this are as follows: (1) Consider CUVAR as a single-precision array of 2(N+1) elements in the DERSUB subroutine and, when using the ith element in a computation, assign to it the subscript value (2i-1), and (2) at the beginning of the DERSUB subroutine, transfer from CUVAR to some newly defined single-precision array and evaluate the derivatives using the latter.

INT1 will also store the tentative answers after each integration in the CUVAR array before calling CHSUB so that the user can check these

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values to decide to accept or reject the answers. If accepted, the CUVAR values will then be transferred to the VAR array. The decision as to whether the computation in the CHSUB subroutine should be done in single or double precision is a function of the individual application. In most cases single precision is adequate and can be accomplished by applying suggestions (1) and (2) in the preceding paragraph to the VAR and CUVAR arrays.

No values need to be initially stored in CUVAR.

- DER An N+1 single-precision array in which the user will store the derivatives evaluated in DERSUB. The derivatives should be arranged by the user in DERSUB in the same order as the VAR block so that DER (2) will be the derivative of the variable stored in VAR (2), for example. DER (1) will be unused. The derivatives must be computed using values of the variables which have been stored in CUVAR (not VAR) by INT1. To avoid unnecessary double-precision computation, the user should apply the suggestion described under CUVAR.
- ELE1 A one-dimensional array of N values supplied by the user each of which is the upper bound of local relative truncation error for the respective dependent variables. If the error for any variable exceeds its respective ELE1 value, the computing interval is halved and the integration restarted at the beginning of the present interval. If the error for all the variables is less than 1/128 of their respective ELE1 values, the computing interval is doubled for the next integration step.
- ELE2 A one-dimensional array of N values supplied by the user which represents a small value or "relative zero" for the respective dependent variables. If the absolute value of any of the variables is less than its respective ELE2 value, the relative error criterion for that variable will not be applied.
- ELT A one-dimensional array of NT values supplied by the user which are values of the independent variable at which the user specifically desires control returned to his program. The values in the ELT block must be monotonic in the direction of integration, or an error return will be given by INT1.
- ERRVAL A one-dimensional array of N elements in which INT1 stores an estimate of the local truncation error for each of the N dependent variables. The relative errors are computed from these values and compared with the specified ELE1 values.

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- DERSUB** A subroutine written by the user which will be called by INT1 to evaluate the derivatives. The derivatives must be stored in the DER array. INT1 will call DERSUB to evaluate the derivatives with the values of the variable it has stored in the CUVAR array.
- These evaluations should be done with the use of single-precision arithmetic. The name given to the DERSUB subroutine must appear in an EXTERNAL statement in the calling program. The user may return to the calling program by storing a 4 in II.
- CHSUB** A subroutine written by the user to allow certain logical control. After each integration step, INT1 will make available to the user in CHSUB the tentative answers in the CUVAR array. The VAR array will contain the last accepted answer (that is, the value of the variables at the beginning of the interval). Whenever the user specifies that the answers are acceptable, the values in the CUVAR block are transferred to the VAR block. In CHSUB the DER block will contain the values of the derivatives evaluated with the present CUVAR block. The user has three options:
- (1) Not change II. In INT1, $II = 1$ denotes that the user has accepted the answers in the CUVAR block. Upon entry to CHSUB from INT1, II always equals 1.
 - (2) Set $II = 2$. The user does not accept the answers and wishes to recompute the interval using a new computing interval which he stores in CI. This computing interval must be smaller than the computing interval just used. This new value of CI will now be stored by INT1 as the normal computing interval for the subsequent integration steps.
 - (3) Set $II = 3$. The user accepts the answer but wishes to denote a condition that he can test in the calling program. Control will be returned to the calling program with the answers in the CUVAR array transferred to the VAR array.
- The name given to the CHSUB subroutine must appear in an EXTERNAL statement in the calling program.
- ITEXT** An integer code word supplied by the user which gives him the option to have INT1 print out a time history of the computing interval and the reasons for its variation. This printout should be requested only for problems which must be rerun because of unsatisfactory results the first time.

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ITEXT = 0: No printout is requested.

ITEXT = 1: A printout is requested.

Restrictions: See arguments listed under CALL statement.

Method: INT1 is a fifth-order integration subroutine. The classical fourth-order Runge-Kutta formula is applied in conjunction with Richardson's "extrapolation to the limit" theory. INT1 is a variable-interval-size routine in which the interval is varied to meet a specified local relative truncation error.

Accuracy: The variable-interval-size mode of logic is used to make available an estimate of the local relative truncation error which is then controlled as explained in the ELE1 block discussion.

Roundoff error is controlled by use of the "partial double-precision mode of computation" as explained in reference (a) of this subroutine.

Reference: (a) Henrici, Peter: Discrete Variable Methods in Ordinary Differential Equations. John Wiley & Sons, Inc., c.1962.

Storage: 2703₈ locations.

Subroutine date: August 1, 1968

APPENDIX B

SUBROUTINE ITR1

Language: FORTRAN

Purpose: To solve the single equation of the form $x = f(x)$ for one real root by the Newton-Raphson iteration method.

Use: CALL ITR1 (X,DELTX,FOFX,E1,E2,MAXI,ICODE)

X	An initial guess supplied by the user. On a normal return to the calling program from ITR1, X contains the root.
DELTX	An increment supplied by the user so that $\frac{f(x + \text{DELTX}) - f(x)}{\text{DELTX}}$ is a reasonable approximation to the derivative of $f(x)$.
FOFX	A function subprogram to evaluate $f(x)$.
E1	Relative error criterion.
E2	Absolute error criterion.
MAXI	A maximum iteration count supplied by the user.
ICODE	An integer supplied by ITR1 as an error code. This code should be tested by the user on return to the calling program. ICODE = 0: Normal return. ICODE = 1: Maximum iteration exceeded. ICODE = 2: Derivative = 0.

Restrictions: A function subprogram with a single argument x must be written by the user to evaluate $f(x)$. The name given to the FOFX subprogram must appear in an EXTERNAL statement in the calling program.

Method: The Newton-Raphson iteration technique (ref. (a) of this subroutine) is used where

$$X_{n+1} = qX_n + (1 - q)f(X_n)$$

$$q = \frac{a}{a - 1}$$

$$a = \frac{f(X_n) - f(X_{n-1})}{X_n - X_{n-1}}$$

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Accuracy: The iteration process is continued until either of two convergence criteria are satisfied. These criteria are

$$(1) \text{ if } \left| f(X_n) \right| \geq \epsilon_1, \text{ then } \left| \frac{f(X_n) - X_n}{f(X_n)} \right| \leq \epsilon_1$$

$$(2) \text{ if } \left| f(X_n) \right| < \epsilon_1, \text{ then } \left| f(X_n) - X_n \right| \leq \epsilon_2$$

Reference: (a) Scarborough, James B.: Numerical Mathematical Analysis. Fourth ed., Johns Hopkins Press, 1958, p. 102.

Storage: 1378 locations

Subroutine date: August 1, 1968

APPENDIX C

SUBROUTINE AT62

Language: FORTRAN

Purpose: AT62 approximates the U.S. Standard Atmosphere, 1962 (ref. (a) of this subroutine). Computes density in slugs/ft³, pressure in lb/ft², temperature in degrees Kelvin, and velocity of sound in ft/sec at any geometric altitude z in the range $-16\,500 \text{ feet} \leq z \leq 2\,320\,000 \text{ feet}$.

Use: CALL AT62 (Z,ANS)

Z	Geometric altitude in feet.
ANS	A one-dimensional array that contains the results.
ANS(1)	Density in slugs/ft ³
ANS(2)	Pressure in lb/ft ²
ANS(3)	Temperature in degrees Kelvin
ANS(4)	Velocity of sound in ft/sec

Restrictions: Range: For altitudes below -16 500 feet the values of density, pressure, temperature, and velocity of sound are not valid. The concept of the velocity of sound in the atmosphere becomes essentially meaningless at altitudes in excess of 300 000 feet. To point out this limitation, the velocity of sound at altitudes above 300 000 feet is set equal to the velocity of sound at 300 000 feet. For altitudes above 2 320 000 feet, density, pressure, and temperature are set equal to their respective values at 2 320 000 feet.

Method: The equations and techniques are identical to those used in computing the U.S. Standard Atmosphere, 1962 (ref. (a) of this subroutine).

Accuracy: The tables in the referenced publication were computed with the IBM 7094 electronic data processing system using some double-precision arithmetic. In converting the routine for the Control Data series 6000 computer systems all double-precision arithmetic was eliminated. Accordingly, there may be slight differences between the results of the converted subroutine and the tables.

Reference: (a) Anon.: U.S. Standard Atmosphere, 1962. NASA, U.S. Air Force, and U.S. Weather Bur., Dec. 1962.

Storage: 1654₈ locations

Subroutine date: August 1, 1968

REFERENCES

1. Garrett, L. Bernard; Suttles, John T.; and Perkins, John N. (With appendix C by G. Louis Smith and L. Bernard Garrett): A Modified Method of Integral Relations Approach to the Blunt-Body Equilibrium Air Flow Field, Including Comparisons With Inverse Solutions. NASA TN D-5434, 1969.
2. Taylor, Frances W.: A Computer Program To Determine Equilibrium-Air Flow-Field Data About A Blunt Body by the Method of Integral Relations. NASA TM X-2041, 1970.
3. Suttles, John T.: A Method of Integral Relations Solution for Radiating, Nonadiabatic, Inviscid Flow Over a Blunt Body. NASA TN D-5480, 1969.
4. Wilson, K. H.: RATRAP - A Radiation Transport Code. 6-77-67-12, Lockheed Missiles & Space Co., Mar. 14, 1967.
5. Scarborough, James B.: Numerical Mathematical Analysis. Fifth ed., Johns Hopkins Press, 1962.



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